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WAR DEPARTMENT

TECHNICAL MANUAL

75-MM GUN MATÉRIEL M1897 AND MODIFICATIONS

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75-MM GUN MATÉRIEL M1897 AND MODIFICATIONS

	Paragraphs
CHAPTER 1. General	1–3
2. Guns and carriages.	
Section I. Data	4–5
II. Description and operation	6–10
III. Disassembly and assembly	11–25
IV. Inspection and adjustment	26–28
V. Malfunctions	29–30
VI. Care and preservation	31–42
3. Sighting and fire-control equipment.	
Section I. Sighting equipment	43–53
II. Fire-control equipment	54–60
4. Ammunition	61–72
5. Caisson, limbers, and reels.	
Section I. Data	73–77
II. Description of parts common to several vehicles	78–83
III. Description of vehicles	84–89
IV. Operation	90–92
V. Disassembly and assembly	93–98
VI. Care and preservation	99–107
6. Organization spare parts and accessories	108–111
7. Subcaliber equipment	112–127
8. Matériel affected by gas	128–130
	Page
APPENDIX. List of references	247
INDEX	249

CHAPTER 1

GENERAL

	Paragraph
Purpose	1
Scope	2
References	3

1. Purpose.—This manual is published for the information and guidance of the using arms and services.

*This pamphlet supersedes TM 9–305, March 31, 1941, and TR 1305–A, February 1, 1933.

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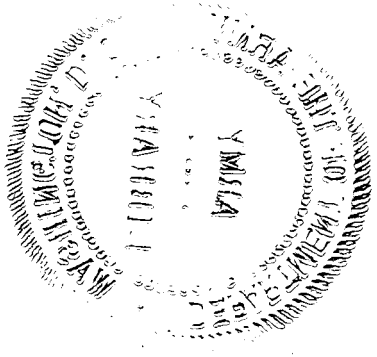
2. Scope.—*a.* In addition to description and figures, this manual contains instructions for the operation, inspection, disassembly and assembly, repair, and care and preservation of the matériel.

b. Disassembly and assembly and such repairs as may be handled by the battery personnel will be undertaken only under the supervision of an officer or the chief mechanic.

c. In all cases where the nature of the repair, modification, or adjustment is beyond the scope and/or facilities of the battery personnel, the local or otherwise designated ordnance service should be informed in order that trained personnel with suitable tools and equipment may be provided or proper instructions issued.

3. References.—All Technical Manuals, Field Manuals, Firing Tables, Standard Nomenclature Lists, and other publications pertaining to the matériel described herein are listed in the appendix.



CHAPTER 2

GUNS AND CARRIAGES

	Paragraphs
SECTION I. Data	4–5
II. Description and operation	6–10
III. Disassembly and assembly	11–25
IV. Inspection and adjustment	26–28
V. Malfunctions	29–30
VI. Care and preservation	31–42

SECTION I

DATA

	Paragraph
Data pertaining to guns	4
Data pertaining to gun carriages	5

4. Data pertaining to guns.—*a. Weight.*

75-mm gun	Weight (pounds)
M1897	1, 015
M1897A2	1, 035
M1897A3	1, 035
M1897A4	1, 035

b. Rate of fire.—A maximum rate of fire of 25 to 28 rounds per minute may be attained, but the advisable rate is 6 rounds. The gun may be loaded at any angle of elevation or depression.

5. Data pertaining to gun carriages.—*a. General.*

75-mm gun carriage	M1897	M1897M1A2	M1897A4	M2A1	M2A2	M2A3
Weight of gun and carriage, complete (without accessories)—pounds	2, 657	2, 657	3, 007	3, 447	3, 447	3, 225
Maximum length of recoil—inches [1]	48	48	48	48	48	48
Height of axis from ground—inches	40. 4	40. 4	44. 4	47⅝	47⅝	47⅝
Maximum elevation—degrees	19	19	19	46	46	45½
Maximum depression—degrees	10	10	10	10	10	10½
Maximum traverse, right—degrees	3	3	3	45	45	30
Maximum traverse, left—degrees	3	3	3	40	40	30

[1] See paragraph 33*b*.

b. Table of recoil mechanisms and carriages.—The table below gives the guns and recoil mechanisms (columns one and two) which are mounted on any carriage (column three). Reading across, any of the guns or recoil mechanisms listed in any one row may be mounted on any of the carriages in the same row.

Gun	Recoil mechanism	Mounted on 75-mm gun carriage
M1897	M1897A3	M1897
M1897A1 M1897A2 M1897A3 M1897A4	M1897A6	M1897A2 M1897M1A2 M1897A4
M1897A2 M1897A4	M1897A5 M2	M2A1 M2A2
M1897A2 M1897A4	M1897A7	M2A3

SECTION II

DESCRIPTION AND OPERATION

Paragraph
Description of 75-mm guns 6
Description of breechblock 7
Operation of breech and firing mechanism 8
Description of carriages 9
Operation of carriages 10

6. Description of 75-mm guns.—*a. M1897.*—(1) The gun (fig. 4) is of French design. A number of these weapons were purchased by the United States. Similar guns were manufactured in this country. The parts of the American and French manufactured guns are identical and therefore interchangeable.

(2) The gun is the built-up type. Name and model are stamped on the left side of the breech hoop. Name of manufacturer, year of manufacture, serial number, and weight, including breech mechanism, are stamped on the muzzle. Data on guns bought from France will be found on top of breech end.

b. M1897A4 and M1897A2.—(1) The M1897A4 gun (fig. 5) is a modification of the 75-mm gun M1897 (French). The modification consists of the removal of rollers and sweeper plates with felt pads, and elimination of a portion of the jacket of the gun, which

is replaced by steel rails and bronze strips attached to supports on the gun.

(2) The M1897A2 gun is standard for new manufacture and is similar in design to the 75-mm gun M1897A4.

7. Description of breechblock.—*a.* The breechblock (fig. 6) is the Nordenfeld eccentric screw type, cylindrical in shape, and threaded on its exterior to fit the breech recess. It has a large diameter compared with the caliber of the gun, because the axis of the breech recess and breechblock are below the axis of the bore of the gun. With this type the breechblock remains in the breech recess during the action of both loading and firing, and the opening and closing of the breech is accomplished by rotating the breechblock 156° around its axis by means of the operating handle. This movement alternately locates the loading hole and the firing pin in line with the chamber of the gun, the movement being limited in each direction by stops against which the breechblock arm strikes. While the mechanism is in the closed position, it is automatically locked until released by action of recoil. The rim of the rear sight serves as a cam to trip the breechblock latch.

b. The gun cannot be fired until the breechblock is rotated to the fully closed position, as only at that point is the firing pin in line with the primer. Rotation of the breechblock to the loading position automatically ejects the empty cartridge case.

c. Two leveling plates in the top of the breech hoop form a surface parallel with the bore, for the application of the gunner's quadrant.

8. Operation of breech and firing mechanism.—*a. Breech mechanism.*—(1) *To open breech.*—Unlatch breechblock by pressing on the operating handle plunger with the thumb. Grasp operating handle with both hands toward the forward position. This will protect the little finger of the left hand from danger of injury by crushing between the pawl and rear sight. Pull upward and push over to left until breechblock arm stops against breechblock stop.

(2) *To close breech.*—Grasp operating handle as in opening the breech, and pull to the right and down until breechblock arm strikes projection stop on lower right on breech face. At the end of this movement the inner end of breechblock latch springs into the grooves in the latch catch in breech face of the gun, latching the breech mechanism in closed position.

b. Firing mechanism.—(1) To fire the piece, pull lanyard sharply down and to the right and release lanyard. This allows the hammer to be thrown forward against the firing pin by means of the firing rack spring with sufficient force to explode the primer.

(2) Safety piece (fig. 6) is provided to prevent accidental firing. The safety piece screws into the threaded recess in the breechblock arm, and may be located at two different points. These two points are marked "Safe" and "Fire" on the outer surface of the breechblock arm. (On guns of French manufacture, these two points are marked "Tir" and "Route.")

9. Description of carriages.—*a. M1897, M1897A2, M1897MIA2, and M1897A4.*—(1) *General.*—(*a*) These gun carriages are of the hydropneumatic, constant recoil type in which the gun when fired recoils sufficiently to permit the carriage to remain stationary. Carriages M1897, M1897A2, and M1897MIA2 are designed to be drawn by horses. They should never be towed behind prime movers at speeds greater than 5 mph. The high speed carriages M1897A4, M2A1, M2A2, and M2A3 are designed to be towed by vehicles up to a speed of 30 mph.

(*b*) The 75-mm gun carriage M1897 (French) (fig. 8) was designed and manufactured in France.

(*c*) Similar 75-mm gun carriages were manufactured in this country copying the M1897 French carriage. All of these carriages were later equipped with a handspike and are now designated M1897MIA2. This carriage was designated M1897MI before the handspike was added.

(*d*) When the M1897 carriages are equipped with handspike, the model designation is changed to M1897A2.

(*e*) When the M1897 (fig. 8), M1897A2, M1897MI, and M1897MIA2 (fig. 10) carriages are equipped with high speed adapters, their model designation is changed to M1897A4 (fig. 11).

(2) *Recoil mechanism.*—(*a*) The recoil mechanism controls the force created by firing and checks movement of recoiling mass in a gradual manner so as not to cause displacement of the carriage. The recuperator system of the mechanism returns the recoiling mass into battery in order that the gun may be fired again.

(*b*) All recoil mechanisms, except the M1897, have been equipped with a respirator, which acts in conjunction with the recuperator in regulating counterrecoil at different temperatures. The respirator head has four indentations in which the respirator cap spring seats when the valve is rotated. These indentations are numbered 0, 1, 2, and 3, indicating the number of holes which may be opened to allow escape of air from the recoil cylinder during counterrecoil.

(3) *Elevating mechanism.*—Located between rocker and cradle. Its function is to elevate or depress the gun with reference to the rocker. Thus the gun can be laid to the desired angle of elevation

for range without disturbing the laying for angle of site or the line of sight ((5) below).

(4) *Range rack and range scale mounting.*—Range rack (fig. 14), range scale, and range rack guide, front, have engraved scales which correspond to the various ranges. The scales are for setting the gun in elevation or depression. Spacing of the graduations is such that when the gun is elevated or depressed, the graduation opposite the index indicates the actual range. The range rack and the range scale are graduated for range in meters. The range rack registers for every 100 meters, and the range scale for every 50 meters. The range rack guide, front, is graduated for every 2 mils. Thus to set the gun for a given range, elevate or depress gun until corresponding graduation of the scale is opposite the index. If the range is given in meters the scale on the rack is used. If it is given in mils the scale on the range rack guide, front, is used.

(*a*) Range scale is located above elevating crank on right of carriage.

(*b*) Any movement between rocker and cradle is indicated by the range scale.

(*c*) Index marks on front and rear guides register the range and elevation on the range rack scale and range rack.

(5) *Angle of site mechanism.*—(*a*) The angle of site mechanism is located between trail and rocker, and provides means for elevating or depressing the rocker with reference to the trail. By means of this mechanism the rocker can be laid to the desired angle of site without disturbing the angle of elevation.

(*b*) The angle of site handwheel (figs. 10 and 15) is perforated with twelve holes which can be engaged with its angle of site handwheel latch (fig. 15), thus locking the angle of site mechanism. The outer face of the angle of site handwheel is divided into 16 equal spaces which are stamped and numbered. One complete turn elevates or depresses the rocker 16 mils.

(*c*) The angle of site pointer (figs. 10 and 15) is a reference for reading graduations on the outer face of the angle of site handwheel.

(6) *Traversing mechanism.*—The carriage can be trained on a target by shifting the trail. A means is provided, however, for closer training through the traversing mechanism. In traversing the carriage the front of the trail slides laterally on its bearings on the axle, describing an arc about the spade. Thus during traverse one wheel advances slightly ahead of the other.

(7) *Shield.*—The shield is for protection of the gun crew. The three types of shields are a four-piece shield of American manufacture,

a four-piece shield of French manufacture, and a seven-piece shield. The American four-piece shield is interchangeable with the French four-piece shield, and either may be used to replace the seven-piece shield. However, the seven-piece shield cannot be substituted on a carriage fitted for either type of four-piece shield.

(8) *Wheels.*—There are two types of 14-spoke wheels, one steel-tired and the other rubber-tired. They are interchangeable on M1897 and M1897MIA2 carriages.

(9) *Wheel fastenings.*—The wheel fastenings consist of axle collars fitted with leather washers and keyed to the axle at the inner ends of the hubs, and axle caps fitted with leather washers held in position by linchpins.

(*a*) Axle collars are rigidly keyed to the axle and take the lateral thrust of the wheels when traveling.

(*b*) Axle caps are held in place by means of linchpins. The outer surfaces of the axle caps bear against the linchpins. The axle caps are so made that there are three separate surfaces that can be brought to bear against the sides of the linchpins, each surface being higher than the other. Thus a means of adjustment for end play is provided. By varying the thickness of the washers in hubs, axle collars, and axle caps, end play may be eliminated.

(*c*) The linchpins are provided with latches which are forced down over the ends of the axles, clamping the pins in position. Leather thongs hold the linchpin latches in position.

b. M1897A4.—(1) The carriage (fig. 11) is a modified 75-mm gun carriage M1897 or M1897MI (*see a*(1)(*b*) above). This modification consists of the removal of seats, seat supports, shaft brackets, steel- or rubber-tired wheels, brake worm support bolts and washers, brake crank pin, and brake crank, and equipping the carriage with a high speed adapter, pneumatic tires mounted on disk and rim wheels, and an internal expanding brake mechanism. Combat tires with commercial heavy duty inner tubes, and wheels of the type having divided rims are now standard. In the future these may be substituted for the pneumatic tires and disk and rim wheels.

(2) In other respects the carriage is the same as the M1897 carriage.

c. M2A2.—(1) The carriage (fig. 26) is of the split trail type built for high speed transport and equipped with either pneumatic-tired disk and rim wheels with internal expanding brakes, or combat tires with commercial heavy duty inner tubes, and wheels of the type having divided rims. Equilibrators neutralize unbalanced weight of the gun and recoil mechanism. When traveling, an offset drawbar provides the spades with road clearance and two locking mechanisms secure the traversing mechanism.

(2) (*a*) Elevating and traversing the weapon are accomplished by elevating and traversing handwheels.

(*b*) Stops are provided to control maximum elevation, depression, and traverse. Trails are spread 90° for maximum traverse. When spread 45°, the traverse is controlled by a stop on the traversing mechanism.

(3) When firing with the trails locked together, the firing jack is not to be manipulated to support the carriage weight, as a three-point support is necessary and consists of the two wheels at the front and the spade end of the trails at the rear. However, under this condition care must be exercised to insure that the total traverse does not exceed 520 mils or the elevation exceed 380 mils.

(4) When the carriage is emplaced with the trails spread, the firing jack will be used to form a three-point support, consisting of the jack and the spades. However, on level ground the piece may be fired safely from the wheels with the trails in either of the spread positions.

(5) Height of the jack is immaterial if it is such as to raise the wheels. On soft ground the jack may sink. It may therefore be necessary to jack up the carriage from time to time. The trails when spread for firing have two symmetrical positions. If necessary, however, one trail may be spread 45° and the other 22½°, if the site has obstructions to prevent spreading both trails to the 22½° or 45° positions.

(6) The recoil mechanism for this carriage is that of the 75-mm gun carriage M1897 (French) modified by removing the elevating mechanism and mounting in a cradle in order to move the axis of elevation of the gun to the rear, thereby attaining a greater maximum elevation (fig. 17).

(7) The cradle is of built-up steel construction. The recoil mechanism is assembled to the cradle by trunnions seated in bearings at the rear of the cradle. The rear of the recoil mechanism is supported on brackets and secured by studs.

d. M2A3.—(1) The carriage M2A3 (figs. 32 and 33) is a modification of the 75-mm gun carriage M2 (fig. 26). This modification consists of the following changes:

(*a*) Firing jack is eliminated and the carriage is equipped with a pivoted axle which automatically adjusts itself to permit laying the piece with the wheels at an angle up to 10° from the horizontal.

(*b*) Top carriage modification consists of removing and relocating of various pads, brackets, and bosses and adding other parts to mounting and elevating mechanism handwheel on the left-hand side of the

carriage, and in providing for cradle and traveling locks. The lower part of the top carriage is modified to provide clearance for the pivoted axle.

(*c*) Trails and spades are modified by reducing the length 19 inches. The drawbar is designed for use with a motorized unit.

(2) The recoil mechanism T7 combines the cradle, recoil, and recuperator (counterrecoil) cylinders. Its function is to check movement of recoiling mass in recoil and counterrecoil in a gradual manner so as not to cause displacement of the carriage.

(3) Other characteristics of the M2A3 carriage are similar to the M2A1 and M2A2 carriages and for detailed information regarding these characteristics reference should be made to these carriages as set forth in this manual.

(4) The gun mounted on the M2A3 carriage is the M1897A4 (fig. 5).

10. Operation of carriages.—*a. M1897, M1897MIA2, and M1897A4.*—(1) *To elevate.*—Elevating crank is on right side of carriage. To elevate, the crank is turned counterclockwise; to depress, it is turned in the opposite direction. One complete turn of elevating crank (figs. 8 and 14) elevates or depresses gun and cradle 8 mils. Limitations of the carriage allow 213 mils (12°) elevation and 0 mils (0°) depression of cradle.

(2) *To set angle of site.*—Angle of site handwheel (figs. 10 and 15) is located on left side of carriage. Release the angle of site handwheel by means of the angle of site handwheel latch handle. Clockwise movement elevates and counterclockwise depresses. One complete turn of the handwheel in one or the other direction elevates or depresses the gun 16 mils.

(3) *To traverse.*—Traversing handwheel (figs. 10 and 15) is on left side. Clockwise rotation of handwheel traverses carriage to left and counterclockwise to right. One turn of handwheel traverses carriage 1.8 mils. Limitations of the carriage allow traverse of 53 mils (3°) right and 53 mils (3°) left.

(4) *To place M1897 or M1897MIA2 carriage in abatage.*—To place in firing position on brake frame, place a man on each side of the trail (fig. 9). Each man grasps a tie rod at the end nearest the right brake beam, lifting it up as far as it will go. Brake latch pin in right brake shaft lever is lifted out of engagement with the lug on the right seat support, and brake shaft levers are pulled back from under brake beam crank tubes, allowing lower end of brake beam frame with its brake shoes to fall to the ground behind the wheels. Lift rear of trail approximately 3 feet from the ground and pull back on trail. Lower

trail; so that the carriage rotates about the spades, and wheels roll back onto brake shoes (fig. 16).

(5) *To remove M1897 or M1897MIA2 carriage from abatage.*—Reverse operations in (4) above.

b. M2A2.—(1) *Elevation.*—Elevating handwheel (fig. 25) is located on right side of top carriage. Stops control elevation and depression.

(2) *Traverse.*—Traversing handwheel (figs. 24 and 26) is located on left side. Traverse depends upon the spread of the trails. When trails are spread to the limit and locked the gun may be traversed 85°. When trails are spread 45°, traverse is limited by a stop on the traversing mechanism to 45°.

(3) *Firing to traveling position.*—(*a*) Prior to traveling, establish an excess of reserve oil in the recoil system. Introduce oil until the index stops moving to the rear.

(*b*) To change from firing to traveling position it is necessary to release the firing jack (figs. 20 and 26). This is accomplished by placing right handspike part way into its socket (fig. 20). Raise jack sufficiently to release tension on the shot bolt. Withdraw shot bolt with left hand and secure it in its disengaged position. Standing clear of the gun barrel, quickly pull out handspike from its socket.

(*c*) Disengage firing jack from axle by pressing on the jack release pedal (fig. 20). Then swing firing jack up and toward the muzzle of the gun and manipulate the cradle by means of the elevating and traversing handwheels until arm of firing jack enters its seat on cradle and is locked in place by cradle lock pin (fig. 23). Rotate cradle lock pin handle 90° upward, then seat and secure it by the turnbuckle. Secure traveling lock located on left of top carriage by rotating it to its rearward position.

(*d*) Withdraw trail lock pins. Close trails and lock them together by means of trail connection hook handle (fig. 30).

(*e*) Turn drawbar downward and lock in this position by means of drawbar lock shaft.

(*f*) Mount accessories to trails and release wheel brakes.

(4) *Traveling to firing position.*—(*a*) Prior to firing, the excess of oil in the recoil system established for traveling should be removed. Take out excess oil until insufficient oil reserve is indicated, then establish a full reserve by inserting oil until the index is flush with the rear surface of the sealing plate.

(*b*) To change from traveling to firing position reverse the operations previously described. In order to jack up carriage insert both

handspikes in firing jack sockets with bent ends of ratchet plunger pins to the outside, and operate handspikes alternately. Insure that spring plunger knob is correctly set to control maximum traverse for the selected trail spread.

(*c*) In an emergency the carriages M2A1, M2A2, and M2A3 may be fired from the wheels with the trails opened. It is also possible to fire the gun on these carriages from the wheels with the trails closed, provided that the gun is not elevated so high that recoiling parts can hit the trails. However, firing from the wheels should not be permitted, especially with the trails closed, except under extreme duress.

c. M2A3 (figs. 32 and 33).—(1) *To change from traveling to firing position.*—Disengage lunette from pintle of prime mover. Lower trails to the ground. Release trail lock, spread trails and lock them in position by means of trail lock pins. Release axle lock, traveling lock, and cradle lock. Lower apron and raise top shield and lock in position. Set brakes (see *b*(3) (*a*) above).

(2) *To change from firing to traveling position.*—Lower top shield and secure it in position. Bring gun in position to engage cradle lock. Withdraw trail lock pins, close trails, and engage trail lock. Engage axle lock to secure axle to the support. Engage traveling lock. Secure drawbar in position with lunette down. Release brakes. Insert lunette into pintle of prime mover and secure by pintle latch (see *b*(4) (*a*) above).

SECTION III

DISASSEMBLY AND ASSEMBLY

	Paragraph
General	11
Disassembly of breech mechanism and breechblock	12
Removal of shields from carriage M1897, M1897MIA2, or M1897A4	13
Dismounting and mounting gun, carriage M1897, M1897MIA2, or M1897A4	14
Dismounting and mounting recoil mechanism, carriage M1897, M1897MIA2, or M1897A4	15
Disconnecting and connecting brake frame to axle, carriages M1897 and M1897MIA2	16
Removal and assembly of wheels, carriages M1897 and M1897MIA2	17
Removal and assembly of axle, carriages M1897 and M1897MIA2	18
Disassembly of gun and carriage M1897A4	19
Disassembly and assembly of high speed adapter, carriage M1897A4	20
Dismounting and mounting gun, carriage M2A2	21
Dismounting and mounting recoil mechanism, carriage M2A2	22
Dismounting and mounting equilibrator, carriage M2A2	23
Disassembly of wheel hub from spindle, carriage M2A2	24
Assembly of wheel, carriage M2A2	25

11. General.—*a.* Incidents of wear, breakage, cleaning, and inspecting make necessary the occasional disassembly of various parts of the gun and carriage. This work comes under two headings, that which may be performed by battery personnel and that which is performed by ordnance personnel.

b. Battery personnel may in general do such dismounting as is required for the assembling of parts indicated in SNL's C–4, C–12, and C–25. Such work should be done in the manner prescribed. Any difficulty which cannot be overcome should be brought to the attention of ordnance personnel.

c. Battery personnel will not attempt to disassemble any part of the recoil mechanism they are not authorized to disassemble, nor do any filing on the sights or gun parts other than outlined, and only by order of the battery commander.

d. Use of wrenches which do not fit snugly on any part should be avoided. They will only fail and will damage the corners of the nuts or bolt heads. Also there is danger of spreading the wrenches and rendering them useless.

e. In assembling, assembly of subassemblies should be completed before attempting to assemble the larger ones in which the subassemblies are placed. In all assembling, bearings, sliding surfaces, threads, etc., should be cleaned and lubricated.

12. Disassembly of breech mechanism and breechblock.—*a. Breech mechanism.*—(1) With breech closed and locked, release breechblock stop (fig. 6) by turning breechblock stop pin until it can be pulled upward through keyway in the stop. After this operation, swing the stop outward to release the extractor spindle. Pull extractor spindle to left until extractor tang is released.

(2) Remove extractor tank (fig. 6) through the loading hole in the breechblock. Push extractor spindle back into its seat and raise the curved end into the lug so that it will be out of the way.

(3) Release breechblock latch from latch catch by pushing in on operating handle plunger. Unscrew breechblock from breech recess by turning counterclockwise. It should be grasped firmly after unscrewing it six turns from closed position, as it will drop out between the sixth and seventh turns. To protect it from the dirt, place breechblock on a bench or paulin before attempting further disassembly.

(4) Withdraw extractor spindle (fig. 6) and remove extractor.

(5) For views of component parts of breech mechanism see figure 7.

b. Breechblock.—(1) Remove safety piece assembly and firing pin (fig. 6) by drawing firing hammer to rear, pulling safety piece plunger knob outward, unscrewing safety piece.

(2) After the firing safety piece assembly and firing pin are removed, press firing hammer assembly as far as it will go into safety piece recess, remove firing hammer pin, then remove firing hammer.

(3) Remove lanyard from firing hammer link (fig. 6) by withdrawing it through eye of breechblock arm.

(4) Remove firing rack assembly, firing rack spring, and firing rack spring assembling pin by pushing operating handle plunger forward and pressing inward on head of pin with a screw driver. One-fourth of a turn will disengage pin from slot in firing rack, from which position it can be withdrawn.

(5) Remove breechblock latch assembly, breechblock latch spring, and breechblock latch pin by turning it approximately one-quarter of a turn outward to disengage it from its retaining groove. Draw pin out of arm. Hold parts as spring forces them out. If spring does not come out, force it by pushing pin through hole in breech face of breechblock arm.

(6) Remove operating handle plunger block, operating handle plunger, and operating handle plunger screw by unscrewing latter and withdrawing parts. If plunger block does not come out, force it by pushing breechblock latch pin through small hole in operating handle.

13. Removal of shields from carriage M1897, M1897MIA2, or M1897A4.—*a. To remove right shield.*—(1) Set carriage at 0° traverse. Remove thong and drive out apron latchkey (figs. 35 and 36) connecting shield staple and brake worm support. Disconnect shield brace by removing cotter pin and washer and withdrawing shield upper pin.

(2) If shield is seven-piece type, remove thong and drive out key connecting right and left shields.

(3) If shield is four-piece type, remove nut and drive out bolt connecting the distance plate and the right shield, and swing distance plate out of the way. Remove thong, drive out key which holds apron in traveling position, and swing apron down. Remove brake crank pin and pull off brake crank. Pull right side of shield to the front until shield staple is free of brake worm support. Pull shield to right and out of socket on trail side plate.

b. To remove left shield.—(1) Remove thong and drive out key connecting shield staple and left shield bracket.

(2) According to the type of shield, proceed as provided above. Pull left side of shield to front until shield staple is free from shield bracket, and pull shield to front.

14. Dismounting and mounting gun, carriage M1897, M1897MIA2, or M1897A4.—*a. Dismounting.*—(1) Provide means for supporting the gun while it is being removed in order to avoid damaging the upper roller path of the recoil mechanism by the front rollers.

(2) Set brake.

(3) Set gun at 0° elevation and see that it is in battery position.

(4) With breechblock removed, raise piston rod coupler key latch and withdraw piston rod coupler key (fig. 16) from right to left as far as it will go. In case it does not work freely, tap key lightly, care being taken not to injure latch. Remove sweeper bolt pin and sweeper plate guide bolt, and withdraw sweeper plate.

(5) Push the gun to the rear, with pairs of men at opposite ends of three heavy timbers, supporting the gun at either end and at the center.

b. Mounting.—Assemble in reverse order of dismounting.

15. Dismounting and mounting recoil mechanism, carriage M1897, M1897MIA2, or M1897A4.—*a. Dismounting.*—(1) Remove screws and sight shield.

(2) To remove range rack screw, raise rear of rocker by turning angle of site handwheel until segment rack of rocker and angle of site worm gear shaft pinion are out of mesh. Lift rear end of recoil mechanism as far as it will go. Remove cotter pin and elevating screw pin by turning handle of pin to about a horizontal position. This disengages the lug of the pin. Swing elevating screw toward rear, free of lugs of rocker, and unscrew from elevating nut. (If force is necessary to remove elevating screw, care must be taken not to damage walls of opening through the screw.)

(3) To remove range scale, turn elevating crank (fig. 14) until range scale reads zero. Drive out crank locking plate pin and pull elevating crank locking plate off yoke. The locking plate brings with it the elevating crank and crankshaft. Remove range scale shaft nut and range scale washer. Remove range scale.

(4) Open right and left trunnion caps by removing thongs and driving out keys. Tap rear end of oil hole housing until it is possible to pry the cap. Remove rocker arm caps by inserting a bronze drift into oil hole. Lift it out.

(5) Raise recoil mechanism clear of trunnion bearings and move it to rear and off carriage. Place mechanism on wood blocks.

b. Mounting.—Assemble in reverse order of dismounting.

16. Disconnecting and connecting brake frame to axle, carriages M1897 and M1897MIA2.—*a. To disconnect.*—(1) Release brake. Shoes should be far away from tires. Remove cotter pins from brake forks and brake fork keys. Pull up on keys and remove.

(2) The next step requires a man on each side of the trail. Each grasps a tie rod at end nearest brake beam and lifts it up as far as it will go. The man on right side of trail uses his left hand to hold tie rod, leaving his other free to turn brake latch pin which engages lug on seat support bracket. He turns latch pin to right, raises it as far as it will go, and pulls backward on brake shaft lever. Drop brake frame on ground and pull backward.

b. To connect.—Assemble in reverse order of disconnection.

17. Removal and assembly of wheels, carriages M1897 and M1897MIA2.—*a. Removal.*—Jack up carriage until wheels are clear of the ground. Block up under front end of trail so as to prevent carriage from tipping or slipping. Withdraw thong from linchpin latch (fig. 9) and swing latch out until it is free. Pull out latch and linchpin. Pull off axle caps.

b. Assembly.—Assemble in reverse order of removal.

18. Removal and assembly of axle, carriages M1897 and M1897MIA2.—*a. Removal.*—Drive off left axle collar. Move axle to the left by means of traversing mechanism until right axle collar comes in contact with right axle bracket. Remove axle sleeve. (Should axle sleeve stick, traverse axle to the right, when sleeve will remain in right axle bracket.) Traverse axle to the right until threads on axle and those in traversing nut are completely disengaged. Pull out axle to the right.

b. Assembly.—Assemble in reverse order of removal.

19. Disassembly of gun and carriage, M1897A4.—Disassembly of gun and carriage, with exception of the high speed adapter, is the same as that outlined for disassembly and assembly of the 75-mm gun and carriage, M1897 and M1897MIA2.

20. Disassembly and assembly of high speed adapter, carriage M1897A4.—*a. To remove disk and rim wheel.*—Wheels must be raised clear of the ground. Remove disk and rim wheel nuts (fig. 28) and then slip disk and rim wheel off.

b. To remove hub and brake drum assembly from spindle.—Remove hub cap and hub cap gasket. Remove cotter pin, nut, and wheel spindle outer washer from wheel spindle. Then slip hub and brake assembly off the wheel spindle.

c. To remove spindle bracket from axle.—First remove disk and rim wheel as in *a* above. The hub and brake drum assembly may also be removed as in *b* above, though this is not necessary. Disconnect radius rod from radius rod bolt stud. Remove seven hexagonal head cap screws which fasten brake shaft in left spindle bracket. Disconnect brake rods from brake shaft. Remove cotter pin and then remove linchpin assembly, axle cap, and high speed axle bracket outer shim if one is used. Spindle bracket may then be slipped off axle.

d. To remove wishbone.—Remove ball socket outer cap from rear end of wishbone, then remove axle clips clamping wishbone to axle. Wishbone is then free.

e. To remove seats.—Remove ball socket outer cap. Disconnect each radius rod at one end. Then upon removing bolts the compensator shaft, compensator shaft support, brackets, and right and left seat and support assemblies can be removed from trail.

21. Dismounting and mounting gun, carriage M2A2.—*a. Dismounting.*—(1) Provide means for supporting gun in a horizontal position while it is being removed in order to avoid damage to gun slides.

(2) With trail spread, place piece on the firing jack, or if left on its wheels, set brake. Depress gun until equilibrator assembling nuts (fig. 22) can be screwed on to equilibrator rod their full length. Elevate gun to 0° elevation and see that gun is completely in battery.

(3) Remove breechblock assembly. Raise piston rod coupler key latch and withdraw key. In case it does not work freely, tap key lightly, care being taken not to injure latch.

(4) Push back gun. When removing gun do not cramp it. Place gun upon wood blocks or some suitable rest.

b. Mounting.—(1) Reverse procedure of *a* above, then elevate and depress piece to be sure of ease of operation.

(2) Assemble breechblock. Lock gun to recoil mechanism by assembling piston rod coupler key.

(3) Depress gun and remove equilibrator assembling nuts (accessory) (fig. 22). Equilibrator trunnion pins must be seated properly in their bearings. Elevate and depress tipping parts to be sure of ease of operation.

22. Dismounting and mounting recoil mechanism, carriage M2A2.—*a. Dismounting.*—(1) Remove telescope mount and range quadrant. Proceed according to instructions outlined in paragraph 21*a*. With screw driver, loosen machine screw (fig. 21) in trunnion nut and remove nut. Remove machine screws in trunnion ball re-

tainer. Remove bolts (fig. 26) in trunnion caps, and remove caps. Raise holding cradle and recoil mechanism sufficiently to slide retainer (fig. 21) trunnion bearing plate, outer, trunnion ball cup, trunnion ball, and trunnion ball spacer from holding cradle trunnions.

(2) In removing parts referred to care must be taken not to bur or bruise them. They should be cleaned and stored in a safe place until reassembled. Inner bearing plate, inner trunnion ball retainer, and trunnion bushing should not be removed.

(3) Lift holding cradle and recoil mechanism clear of top carriage trunnion bearings. Place mechanism on wood blocks.

NOTE.—Each holding cradle and recoil mechanism is considered a unit and must be shipped and handled as such since location of studs which secure recoil mechanism to cradle are in a different position on each recoil mechanism.

b. Mounting.—(1) Lift holding cradle and recoil mechanism into position, trunnions of cradle being in line with trunnion bearings of top carriage, and with sufficient clearance to assemble the trunnions.

(2) Clean trunnion bushings (fig. 21) and coat them lightly with medium mineral lubricating grease. Assemble the following parts in the order given: Trunnion ball, trunnion ball cup, trunnion ball spacer, trunnion bearing plate, outer, and trunnion ball retainer, outer, coating each part with grease.

(3) Lower cradle and recoil mechanism into top carriage trunnion bearings. Assemble trunnion caps with bolts (fig. 21). Line up screw hole in trunnion ball retainers, inner (fig. 21) and outer, trunnion bearing plates, inner and outer, and trunnion caps and top carriage trunnion bearings, and assemble machine screws. Screw trunnion nuts on cradle trunnions and lock in position by tightening machine screws. Replace telescope mount and range quadrant.

23. Dismounting and mounting equilibrator, carriage M2A2.—*a. Dismounting.*—(1) Place carriage in firing position. Depress gun until equilibrator assembling nuts (accessory) (fig. 22) can be screwed on to equilibrator rods their full length, using socket wrench.

(2) Elevate gun, then raise and withdraw equilibrator through rear opening of top carriage.

NOTE.—The equilibrator trunnion pin may be adjusted or removed by first releasing the equilibrator trunnion pin lock. Further disassembly of the equilibrator by the using arm is prohibited.

b. Mounting.—Elevate gun and insert ball portion of equilibrator (fig. 22) into its seat. Assemble equilibrator trunnion pin, making proper adjustment by screwing pin in or out. Depress gun until

equilibrator trunnion pin is properly seated. Assemble equilibrator trunnion pin lock.

24. Disassembly of wheel hub from spindle, carriage M2A2.—Remove machine screws from hub cap. Remove cotter pin from wheel spindle. Remove slotted nut and disk and rim wheel spindle washer. When pulling hub from spindle be sure to protect roller bearing from falling to the ground.

25. Assembly of wheel, carriage M2A2.—*a.* If hub is removed from spindle the cavity of hub should be cleaned with dry-cleaning solvent and wiped dry. Fresh grease should be packed around roller bearings before assembly.

b. Slide hub over spindle, guiding cup of inner roller bearing over cone and rollers and brake drum. Slide outer cone and roller of bearings on spindles and guide them into their seats in roller bearing cups. Assemble disk and rim wheel spindle washers, outer, and slotted nuts on spindles. Tighten nuts sufficiently to allow wheels to revolve freely without end play. Assemble cotter pins. Attach hub caps with machine screws.

SECTION IV

INSPECTION AND ADJUSTMENT

	Paragraph
Gun	26
Carriage	27
Sighting equipment	28

26. Gun.—The following instructions should be scrupulously observed:

Parts to be inspected in order of inspection	*Points to observe*
a. Gun.	*a.* Note general appearance, smoothness of operation of breech mechanism in opening and closing, action of operating handle plunger and firing mechanism with lanyard. Note condition of bore for copper deposits on lands and in grooves, and erosion at origin of rifling. Examine breech recess for scored and bruised threads and leveling plates for burs or other defects. Examine gun slide bearings or rollers for burs, dents, cleanliness, proper lubrication, and rigidity of the assembly. The bronze slides of the

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Parts to be inspected in order of inspection	*Points to observe*
	M1897A4 gun should fit the rails tightly, but the rails should be able to move longitudinally from their anchor at the jacket support. Insure that barrel supports and jacket and muzzle hoops are tight. Examine safety bolt assembly for deformed lug and for condition of the spring.
b. Breech mechanism.	*b.* Disassemble and clean breech mechanism. Examine breechblock for any defects, also firing pin. Examine firing hammer and firing rack for burs or bruises. Test action of firing rack spring by pulling lanyard. Note striking force of firing hammer.
c. Extractor tang.	*c.* Note deformation or breakage.
d. Extractor spindle.	*d.* Note evidence of scoring or binding.
e. Extractor.	*e.* Check for broken lips, scoring, or binding.
f. Safety piece.	*f.* Bruised threads or deformed hammer stop screw.
g. Firing pin.	*g.* Deformed point, protrusion.
h. Firing hammer.	*h.* Deformed gear teeth.
i. Firing rack spring assembling pin.	*i.* Deformed projections.
j. Firing rack.	*j.* Condition of teeth and screw.
k. Firing rack spring.	*k.* Weakness or breakage.
l. Breechblock latch pin.	*l.* Binding or breakage.
m. Breechblock latch.	*m.* Wear or breakage, worn pawl, weak or broken pawl spring.
n. Breechlock latch spring.	*n.* Weakness or breakage.
o. Operating handle plunger screw.	*o.* Condition of threads.
p. Operating handle block.	*p.* Worn or broken projections.
q. Operating handle plunger.	*q.* Condition of threads and scores on exterior.
27. Carriage.	
a. Carriage.	*a.* General appearance. Note condition of carriage paint, and that all moving parts are lubricated.

Parts to be inspected in order of inspection	*Points to observe*
b. Recoil mechanism.	*b.* Release reserve oil in recuperator. Note action of oil indicator and whether it recedes. Replenish oil reserve and see that oil indicator moves out as oil is forced into recuperator. Examine front end of recoil cylinder, filling and drain plug hole, and oil index recess for leakage. Presence of a few drops of oil in any of these places will in no way affect the recoil mechanism. When any undue leakage is present, the use of the recoil mechanism is prohibited. Return to ordnance personnel for repair.
c. Elevating mechanism.	*c.* Elevate and depress the gun the full extent of travel. Note binding or undue backlash.
d. Angle of site mechanism, carriages M1897, M1897MIA2, and M1897-A4.	*d.* Elevate and depress rocker through full extent of travel. Note any undue binding or backlash.
e. Traversing mechanism.	*e.* Traverse carriage. Note smoothness of operation, binding, or backlash.
f. Brake mechanism, carriages M1897A2 and M1897MIA2.	*f.* See that brakes operate freely. (1) Try the wheel brakes by jacking up carriage and standing on a spoke. Neither wheel should revolve. (2) Lower brake mechanism to firing position and test carriage as to whether it may be traversed from extreme right to left without opposition from brake frame. (3) Latch brake mechanism and test latches.
g. Shield.	*g.* Examine shield, and note whether all keys, thongs, hinges, etc., are in serviceable condition.
h. Trail.	*h.* Loose rivets, nuts, and screws.
i. Wheels, steel-tired, carriages M1897 and M1897MIA2.	*i.* Test tightness by tapping lightly with a hammer. (1) Tightness of hub bolts. (2) End play by grasping spokes and moving wheel in and out.

Parts to be inspected in order of inspection	*Points to observe*
	(3) Remove wheel and note condition of inner and outer washers. Note condition of hub liner, spindles, and exposed parts of axle.
	(4) Replace wheel and take up end play; make certain that leather washer in axle collar is not less than ⅛ inch thick.
	(5) Pull out on top and push in on bottom of wheel. Hold wheel in this position and place a scale or straightedge on shield with its end touching inner edge of top of tire. Then push in on top and pull out on bottom of wheel. The distance between end of scale and inner edge of the top of the tire represents the rock of the wheel on the axle. The maximum allowable rock is 0.281 (9/32) inch, representing an increase in diameter of hub liner of 0.06 inch. When hub liner is beyond this limit, it must be replaced.
j. Brake mechanism, carriages M1897A4 and M2A2.	*j.* Test brakes by placing carriage in firing position, wheels clear of the ground. Set brake hand levers. Note position of brake ratchet pawl. If in last tooth of brake ratchet, brake shoes should be adjusted. Release brake hand lever to "off" position. Note whether wheels revolve freely.
k. Trails, split (75-mm gun carriage M2A2).	*k.* Place carriage in position. Move trails to 45° position. Note that they swing freely. Examine trail connection. See that it locks the trails together without unnecessary strain.
	(1) Test drawbar lock. Note whether drawbar lock shaft enters hole in drawbar arm without force.
	(2) Examine all supports and fastenings.
l. Wheels and tires on carriages M1897A4 and M2A2.	*l.* Examine nuts. Note condition and whether they are set up tight. Note whether rim is deformed.

Parts to be inspected in order of inspection	*Points to observe*
m. Wheel, disk, and rim, with tire, assembly (75-mm gun carriages M1897A4 and M2A2).	*m.* Test wheels to see that they have proper toe-in of 1/8 of an inch and revolve freely and that there is no wobble. If wheels wobble, examine spindles to see that they are not bent. Examine wheels for warping. Examine tires to see whether crown of tire is taking the wear. If worn to left or right of crown, test alinement of wheels.
n. Traveling lock of M2A2 carriage.	*n.* Examine for performance of its function.
o. Traversing rack of M2A2 carriage.	*o.* Examine traversing rack for broken or deformed teeth.
28. Sighting equipment.	
a. General.	*a.* Inspect for general appearance and lubrication. Note undue lost motion in operation of various gears. Check level vials to insure that they are tightly secured in their holders.
b. Telescope mount.	*b.* Insure that all parts are properly assembled and that various screws and studs are tight. Check the ease of operation for travel and for firing. Inspect alinement and if necessary adjust telescope mount. Check lubrication.
c. Panoramic telescope.	*c.* Check lubrication. Inspect alinement and if necessary adjust.
d. Range quadrant.	*d.* Check lubrication. Inspect alinement and if necessary adjust.

SECTION V

MALFUNCTIONS

	Paragraph
Gun	29
Recoil mechanism	30

29. Gun.

Malfunction	*Cause*	*Correction*
a. No momentum of firing hammer.	*a.* Broken firing rack spring.	*a.* Replace.

Malfunction	*Cause*	*Correction*
b. Fails to fire until after several percussions on primer.	*b.* Firing rack and hammer not working freely.	*b.* Disassemble firing mechanism completely and examine all parts for burs or roughened surfaces. Remove burs or rough spots with fine file or oilstone. Wash all parts with dry-cleaning solvent. Dry thoroughly and lubricate with oil, engine (SAE 10 for temperatures below 32° F., or SAE 30 for temperatures above 32° F.).
	(1) Weak firing rack spring.	(1) Replace.
	(2) Deformed or broken firing pin point.	(2) Replace.
c. Fails to discharge; no percussion on primer.	*c.* (1) Safety piece not locked.	*c.* (1) Set safety piece plunger properly in breechblock arm.
	(2) Breechblock not fully closed.	(2) Close breechblock.
d. Fails to extract cartridge case.	*d.* Broken extractor.	*d.* Ram the case out gently from the muzzle end. Examine edge of chamber for deformation or burs which might cause difficult extraction. Disassemble mechanism and replace extractor if necessary.
e. Pawl fails to operate.	*e.* Broken pawl spring or broken breechblock latch spring.	*e.* Disassemble breech mechanism until pawl can be removed. Examine springs and if latch spring is broken replace it. If pawl spring is

Malfunction	*Cause*	*Correction*
		broken, replace with new breechblock latch assembly.
f. Breechblock does not rotate freely.	*f.* (1) Lack of lubrication.	*f.* (1) Remove breechblock. Clean block thoroughly and recess with dry-cleaning solvent. Wipe thoroughly dry. Lubricate with oil, engine (SAE 10 for temperatures below 32° F., or SAE 30 for temperatures above 32° F.), and assemble.
	(2) Burs or roughness on threads of breechblock or in breech recess.	(2) Remove breechblock and clean block and recess as in (1). If burs or roughness are found, correction must be made by ordnance personnel.
g. Safety bolt can be pushed down by hand after piston rod coupler key is removed.	*g.* Broken spring. Weak spring or spring not engaging in notch.	*g.* Replace with new safety bolt assembly or refer to ordnance personnel.
h. Safety bolt fails to rise.	*h.* Broken lug.	*h.* Replace safety bolt assembly.
i. Safety bolt does not remain in upper position when coupler key is withdrawn.	*i.* Weak or broken spring. Spring does not engage in notch.	*i.* Replace safety bolt assembly.

30. Recoil mechanism.

Malfunction	*Cause*	*Correction*
a. Oil leaking into front of recoil cylinder.	*a.* Failure of piston packing or wear of cylinder wall.	*a.* Notify ordnance personnel.
b. Oil leaking into filling and drain plug recess.	*b.* Failure of filling valve.	*b.* Notify ordnance personnel.

Malfunction	*Cause*	*Correction*
c. Oil leaking around oil index.	*c.* Failure of packing.	*c.* Notify ordnance personnel.
d. Oil index not functioning.	*d.* Index stuck.	*d.* Withdraw reserve oil and insert approximately one-half the capacity of the oil screw filler. Tap oil index lightly as oil is being added.
e. Failure of gun to return into battery.	*e.* Insufficient oil reserve.	*e.* Withdraw reserve oil; insert sufficient oil to bring oil index even with rear face of cylinder rear sealing plate.
	(1) Low nitrogen gas pressure.	(1) Notify ordnance personnel.
	(2) Excessive friction.	(2) Notify ordnance personnel.
	(3) Damaged slides, piston rod, or piston.	(3) Notify ordnance personnel.
f. Return of gun into battery with a shock.	*f.* (1) Too much reserve oil.	*f.* (1) Withdraw reserve oil. Insert sufficient oil to bring oil index even with rear face of cylinder rear sealing plate.
	(2) Air from recoil cylinder escaping too fast through respirator.	(2) Adjust respirator to small air vent. If this fails to correct trouble, withdraw oil reserve as indicated in (1).
g. Stiff operation of elevating handwheel—if the force required to operate elevating handwheel exceeds 10 pounds at any point throughout the range of elevation, this is a malfunction.	*g.* (1) Improper adjustment of equilibrator.	*g.* (1) Adjust — see paragraph 23.

Malfunction	*Cause*	*Correction*
	(2) Scored bearings or improper lubrication.	(2) Check lubrication. If this does not remedy, notify ordnance personnel.
h. Operation of elevating handwheel or traversing handwheel is jerky or binding.	*h.* Worn or loose bearings and gears.	*h.* Notify ordnance personnel.
i. Excessive backlash in elevating or traversing mechanism.	*i.* Worn gears or bearings.	*i.* Notify ordnance personnel.
j. Force required to operate traversing handwheel exceeds 10 pounds.	*j.* Worn gears or bearings.	*j.* Notify ordnance personnel.

SECTION VI

CARE AND PRESERVATION

	Paragraph
Gun	31
Carriage	32
Recoil mechanism	33
Recoil oil	34
High speed adapter	35
Brake mechanism, carriage M2A2	36
Lubrication instructions	37
Cleaners and abrasives	38
Preservatives	39
Paint and related materials	40
Lubricants	41
Miscellaneous materials and tools	42

31. Gun.—*a. General.*—(1) It is important that whenever the rate of fire permits, the cannoneer look through the bore before each loading to ascertain whether or not particles of cartridge case, wadding, or unburned powder remain in the bore. Presence of such particles may cause damage to the piece. During night firing the chamber should be swabbed between rounds.

(2) If enemy shell burst near the gun, be sure before firing that the gun has not been damaged to a dangerous degree. Damage of a serious nature should be reported to the ordnance officer.

(3) In cleaning after firing, wash bore with a solution of ½ pound of soda ash or 1 pound of sal soda in 1 gallon of water. Use a piece of burlap or cleaning cloth around the metal end of the rammer staff for swabbing. When all powder fouling has been removed, swab bore with clear water and finally dry bore with a piece of clean burlap or cleaning cloth.

(4) Leveling plates should be protected. Tools or other articles will not be placed upon them. In case of injury repair must be made by ordnance personnel.

(5) In order to clean oil well, muzzle rollers, and covers, the roller side plates of the M1897 gun (fig. 4) should be removed. Remove them by unscrewing muzzle roller center screw.

(6) Slides of the M1897A4 gun (fig. 5) should be examined by pushing the gun to the rear until three-quarters of the bearing strips, left and right, are exposed. Burs or rough spots should be removed with a fine file. Wash the strips with dry-cleaning solvent and wipe dry. Coat the strips with oil, engine (SAE 10 for temperatures below 32° F., or SAE 30 for temperatures above 32° F.), and push gun into battery. Periodically, the gun should be removed from the carriage in order to clean the entire length of the slides.

(7) Lubricating instructions are given in paragraph 37.

(8) When matériel is not in use, covers must be used.

(9) When gun is not to be used for a considerable time, the bore, breech mechanism, and bright and unpainted surfaces should be cleaned with dry-cleaning solvent and surfaces coated with rust-preventive compound.

b. Breech mechanism.—(1) Should be kept clean and parts well lubricated. When not in use disassemble periodically, especially for detection of rust. When in use, disassemble frequently, clean and oil. It should be so cared for immediately after firing.

(2) In removing rust-preventive compound the greater part should be scraped off. The remainder should be removed with dry-cleaning solvent used on a rag or waste.

(3) A steel hammer must not be used directly on any part of the mechanism. A copper drift or a hardwood block should be interposed, or a copper hammer used.

(4) Vigilance must be exercised to detect any cutting or abrasions on the pressure side of the threads of breechblock and breech recess. If breechblock does not rotate smoothly or if it requires a greater effort than usual to operate, it should be disassembled and examined. Scoring or bruises on threads of breechblock or breech recess should be reported to ordnance personnel.

c. Firing mechanism.—(1) The parts require the same attention as the breech mechanism. Therefore, frequent disassembly for the purpose of cleaning and oiling is required.

(2) Fouling of the firing pin or the use of a thicker oil than authorized will cause absorption of the energy of the firing rack spring and firing hammer and may result in misfire. This is especially true in cold weather.

(3) Wear in this mechanism is negligible. Deformation may be on the rear end of the firing pin. This wear may cause sticking in the safety piece. If the firing pin is examined after each firing, replacement can be anticipated.

32. Carriage.—*a.* Attention should be given to cleaning, lubrication, and loose or broken parts. Lubrication, with method and frequency of application, is covered in detail in paragraph 37.

b. Bearing surfaces, revolving parts, springs, gear teeth, brake mechanisms, screw threads, and exterior parts must be clean and free from dirt. Special attention should be given to exposed gear teeth and bearing surfaces. In disassembling and assembling operations, precautions must be taken to prevent entrance of foreign matter.

c. (1) Wheels pertaining to the M1897 and M1897MIA2 carriages should be removed periodically for examination and cleaning of axle, axle collars and washers, axle caps and washers, linchpins, and hub boxes. Roughness due to scoring or cutting should be smoothed off.

(2) Nuts on hub bolts should be tightened frequently during the first year, and at least twice a year thereafter. Ends of bolts are lightly peened over. Wooden parts are made of seasoned material and hub bolts are properly tightened, but in time the wood dries and shrinks and the spokes become loose. If used in this condition wheels may become damaged, unfit for service. Wheels should not be soaked in water to tighten tires by expanding the wooden rims.

(3) Axle caps allow three adjustments before it is necessary to add washers. Leather washers should be placed between outer end of hub and axle cap so that after the linchpin is in place the wheel has only a slight longitudinal play. There should be at least one leather washer between hub and axle collar. Axle caps are notched, therefore effort should be made to obtain the above results with the deepest notch in axle caps. Reduce the longitudinal play by placing linchpins in shallow notches.

d. Carriage should be given a general inspection periodically.

e. Care and maintenance of the carriage require the use of the cleaning and preserving materials issued by the Ordnance Department.

f. When carriage is stored or is to remain unused for a considerable length of time, all bright and unpainted surfaces should be protected with a coat of rust-preventive compound. Before applying the compound the surfaces should be cleaned with dry-cleaning solvent.

33. Recoil mechanism.—*a. Precautions to be taken before firing.*—Do not begin firing until it is determined that the recoil mechanism is in satisfactory condition. Check the following points:

(1) Examine for oil leakage around the front of the recoil cylinder, filling and drain plug hole, and oil index recess. Report to ordnance maintenance personnel any indication that oil has been dripping from the recoil mechanism.

(2) Firing should not be undertaken with an excess or lack of reserve oil. The oil reserve is indicated by the position of the oil index with reference to the rear face of the recuperator cylinder rear sealing plate, as follows:

(*a*) *None.*—Indicator is well into recess.

(*b*) *Full.*—End of index is flush with rear face of recuperator cylinder rear sealing plate.

(*c*) *Excess.*—Index projects beyond rear face of cylinder rear sealing plate.

(3) Wipe front of recoil cylinder clean. Holes in respirator must not be plugged.

(4) Slide and roller paths of cradle must be clean and properly lubricated.

b. During firing.—(1) During firing, the action of the mechanism should be noted and the functioning of the gun checked with respect to—

(*a*) *Recoil.*—Gun recoils its prescribed distance.

(*b*) *Counterrecoil.*—Gun returns into battery without shock.

(*c*) *Leakage.*—Leakage of oil from filling and drain hole, oil index recess, and front of recoil cylinder is not excessive.

(2) The maximum recoil for this gun should not normally exceed 48 inches (par. 5*a*). If this limit is exceeded, the gun will not be fired again until permission is obtained from the proper ordnance personnel. Variations in the length of recoil are caused by variations in the force the recoil mechanism must absorb. This force varies with changes in powder charges, position of the trails, and elevation. Changes in the length of recoil are also caused by differences in temperature, in the condition of the packing, in the number of times a mechanism has been fired since the last reconditioning, and in the number of times the mechanism has been reconditioned. For instance,

low recoil and consequent insufficient counterrecoil may be due to sluggishness of the oil when the mechanism is cold, to movement of the trails when the spades are not firmly embedded, or to low powder charges.

c. Before traveling.—When carriages are to travel or to be used at drill, recoil mechanisms will be filled to create an excess reserve of oil as described in *a*(2)(*c*) above. An excess reserve has been found necessary due to contraction of the oil, which permits the gun to slide to the rear sufficiently to bring the rollers on the roller paths, thereby indenting them. Care should be taken to establish a normal reserve before firing.

d. To reduce or exhaust oil reserve.—(1) Remove the filling and drain plug.

(2) Screw in the filling and drain valve release.

(3) Oil flows out through release.

(4) Unscrew release as soon as indicator begins to recede. If it is desired to eliminate the reserve completely, wait until flow stops.

e. To replenish oil reserve or establish excess oil reserve.—(1) Use oil screw filler.

(2) Inject oil, watch oil indicator, and stop injecting oil when indicator reaches normal or excess reserve as described in *a*(2)(*b*) and *a*(2)(*c*) above.

f. To attach oil screw filler.—(1) Remove filling and drain plug.

(2) Unscrew piston as far as possible. Unscrew nut. Remove cover from filler. Fill filler with oil to within 1 inch of top, holding finger over nozzle.

(3) Insert piston and tighten nut.

(4) Give a few turns to screw, holding nozzle upward so as to remove air. This is indicated when there are no bubbles.

(5) Screw filler into filling and drain plug hole. Care should be taken to hold the filler straight so as to engage the threads. Give a few turns to screw so as to force out any air.

(6) Screw in the piston of the filler.

(7) Watch oil index and stop injecting oil when it reaches the rear face of the recuperator cylinder rear sealing plate. About one-half the capacity of the oil screw filler is required.

NOTE.—Care must be taken to avoid breaking end of filler or damaging threads in filling and drain plug hole. Trouble is caused by attempting to operate the oil screw filler with one hand. In operating the filler the handle should be so that it projects an equal distance on either side of the screw, both hands being used. With this method of operation the filler can be operated successfully and without damage.

g. To remove oil screw filler.—(1) Unscrew filler.

(2) Empty and put on nozzle cover.

(3) Replace filling and drain plug.

h. Nonfunctioning of oil index.—(1) Sometimes the oil index does not register when oil is being injected. For this reason an excessive amount of oil may be injected.

(2) An excessive amount of oil is dangerous, as during recoil the control rod will jam. This will damage or may cause destruction of the recoil mechanism.

(3) If the oil index does not move in when oil is being extracted or if it does not move out when oil is being injected, it is probable that the packing around the oil index is too tight. On the other hand the index may be broken or frozen.

(4) In order to test the oil index, by means of the filling and drain valve release, drain all the oil that will run out. After removing filling and drain valve release, inject oil by means of the oil screw filler. While injecting oil, tap index lightly on each turn of the oil screw filler. If index does not move out after about half the capacity of the oil screw filler has been injected, it is an indication that there is something wrong with the mechanism and the ordnance officer should be notified. If index works properly after the operation described the reserve oil supply should be injected and drained off about three times to insure that index is in working condition.

i. Use of recoil mechanism in emergency.—In an emergency it may become necessary or desirable to fire the gun without reference to the action of the oil index. The procedure is to assemble filling and drain valve release and extract all reserve oil. Refill mechanism with one and one-half fills of the oil screw filler. Remove oil screw filler and assemble filling and drain plug. Firing may then proceed until gun returns into battery with shock. Shock indicates that heat has expanded reserve oil and that some of it should be released. If mechanism is losing oil through leakage around packing, firing may continue until gun does not return into battery position.

j. General care.—All nonbearing surfaces should be kept painted. Bearing surfaces must be clean and lubricated. The felt wipers attached to the sweeper plate of the M1897 and M1897MI guns should be kept in good order and well lubricated.

34. Recoil oil.—*a. General.*—(1) The recoil mechanisms use heavy recoil oil with low pour point. Care must be taken not to use oil other than that prescribed.

(2) (*a*) Water or air must not be introduced into recoil mechanisms.

(*b*) Exposure of recoil oil in an open can may result in accumulation of moisture. Condensation in a container partly filled with oil or pouring from one container to another which has moisture on its inner walls results in moisture being carried along with the oil into recoil mechanisms.

(*c*) It is advisable that recoil oil be tested for water. Use a clean glass bottle of a pint capacity filled with recoil oil. Oil should be allowed to settle. If water is present, the water being heavier than the oil, the water will sink to the bottom. With the bottle slightly tilted, drops or bubbles will form in the lower portion. Invert the bottle and hold to the light. Drops or bubbles of water if present may be seen slowly sinking in the oil. If the oil has a cloudy appearance the cloudiness may be ascribed to particles of water. Another test is to heat a shallow pan of oil to boiling. Water in the oil will appear on the surface as minute bubbles. This test will disclose water not determinable by the settling test.

(*d*) If either of these tests shows water, the oil on hand should be turned in.

b. Care.—(1) Transfer of recoil oil to a container not marked with the name of the oil may result in wrong oil getting into recoil mechanisms or in use of recoil oil for lubricating purposes. Recoil oil must not be put into container not marked with name of the oil.

(2) The following should also be observed:

(*a*) Recoil oils should not be left in open containers nor subjected to excessive heat.

(*b*) Greatest care must be taken with recoil oils to exclude moisture and dirt.

(*c*) Strain through clean cloth before inserting in recoil mechanism.

(*d*) Do not mix recoil oils with any other type of oil.

35. High speed adapter.—*a.* (1) As brake linings wear, it is necessary to adjust brakes in order that brake linings may come in contact with brake drums. Adjustment is made by the brake adjusting wedge being turned to the right one or two notches. After adjustment, wheel should revolve without drag.

(2) Carriage should be jacked up periodically and wheels revolved. Wheels should turn freely with no excessive side play. To determine side play, grasp sides of tire and shake wheel back and forth. If there is excessive side play remove hub cap and cotter pin from spindle and tighten spindle nut until side play is removed. Reassemble cotter pin and hub cap.

b. Carriage should not be moved any great distance with tires partially inflated, as side walls are unduly bent and fabric is sub-

jected to stresses which cause rim cutting. Test tires daily. Those on the M1897A4 carriage should be inflated to 25 pounds' pressure, and those on the M2A2 carriage should be inflated to 30 pounds' pressure.

c. Screws, bolts, and nuts should be tested once a week and set up tight. Lock washers should be examined and replaced if necessary.

d. (1) Grease fittings of the adapter should be washed and cleaned in dry-cleaning solvent at least semiannually, and when the carriage has had hard usage. Grease should be injected once a month into all bearings.

(2) Wishbone should be lowered from the axle collars once a year and then raised to see that it has maintained its alinement with the grooves in the axle collars.

(3) Ball socket inner and outer caps should be removed periodically and examined for defects. Compensator ball stud spring should be replaced if found to be weak or rusted.

(4) Radius rod group should be disassembled periodically and cleaned to remove foreign matter that may have collected. When reassembling, the parts should be lubricated.

(5) Wheels, hubs, and brake drums should be removed after every 1,000 miles. All grease should be removed from hub cavities, and hub and inner and outer roller bearings washed with dry-cleaning solvent. When assembling, ball bearings must be packed with wheel bearing grease.

36. Brake mechanism, carriage M2A2.—*a.* Functioning of the brake is of vital importance. A freely operating brake insures a longer period of operation before readjustment becomes necessary.

b. Brake adjustment is accomplished by rotating the brake shoe adjusting wedge (fig. 34) in the desired direction. The wedge extends to the outside of the brake housing plate. The end of the adjusting wedge on which a wrench may be used is square.

c. (1) Procedure for adjusting brakes is—

(*a*) Set hand brake lever at full released position.

(*b*) Jack up wheel.

(*c*) Adjust brake adjusting wedge until a drag is felt on wheel. Back off just enough so that there is no drag. Brakes must be cold when making this adjustment.

(2) Position of hand brake lever and toe of brake shoe can be adjusted as follows:

(*a*) Remove disk-and-rim wheel hub and brake drum.

(*b*) Loosen locking nut at bottom of hand brake lever.

(*c*) Drive out brake cam shaft sufficiently to permit its splined section to rotate free of brake lever.

(*d*) Rotate brake cam the desired amount in the same direction it moves when brakes are applied to force the shoes upward, and replace cam in its operating position.

(*e*) Tighten brake lever locking nut, and reassemble disk-and-rim wheel hub.

d. Wheel bearings should be adjusted to prevent drag.

e. Brake cam and rollers are lubricated through fittings. Lubrication must be correct to avoid saturating the brake lining. Overlubrication will cause heavy brake handle pressure and many make necessary replacement of brake linings. Linings may be cleaned with dry-cleaning solvent.

37. Lubrication instructions.—*a.* Excessive wear can be prevented by keeping matériel clean and well lubricated. The life of gun and carriage depends on proper lubrication. Particular attention should be given to sliding and bearing surfaces such as inclined planes on gun and cradle and roller paths, roller bearings, and breech mechanism.

b. The lubrication charts shown in figures 1, 2, and 3 are provided as a guide for proper lubrication.

38. Cleaners and abrasives.—See *TM 9–850 for those prescribed, their application, and use. The following are prescribed:

Burlap, jute, 8-ounce, 40 inches wide.
Cloth, crocus.
Cloth, emery, No. 00, No. 0, and No. 1.
Cloths, wiping, cotton, mixed, sterilized (for machinery).
Compound, cleaning.
Lime, hydrated (lime slaked and powdered).
Paper, lens, tissue.
Paper, flint.
Polish, metal, paste.
Remover, paint and varnish.
Soap, saddle.
Soda ash.
Soda, caustic (lye), for cleaning purposes.
Solvent, dry-cleaning.
Sponges.
Waste, cotton (two grades, colored and white).

*See list of references (appendix).

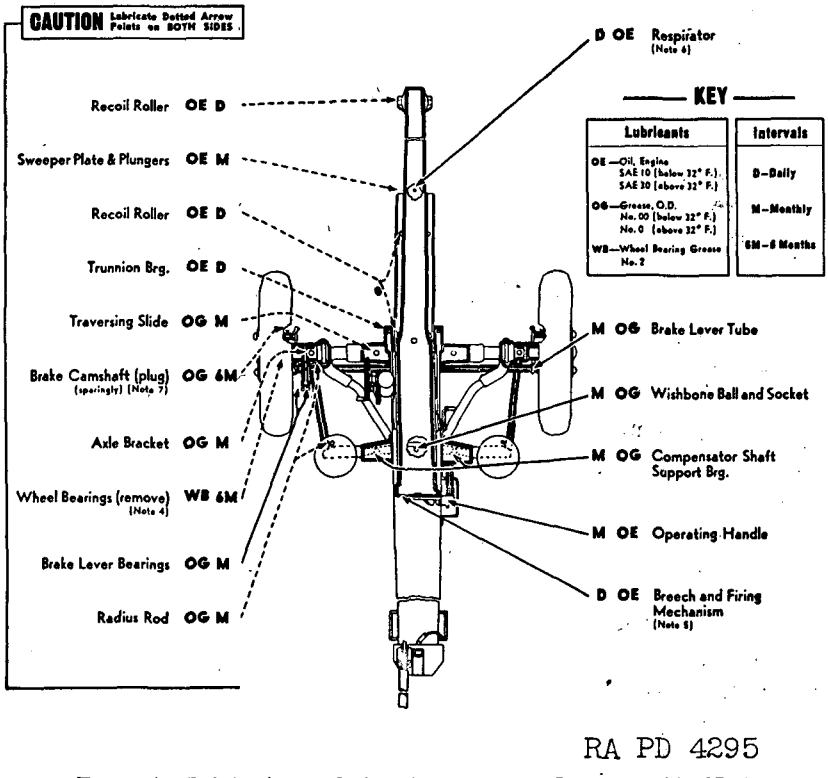


FIGURE 1.—Lubrication guide for 75-mm gun M1897; carriage M1897A4.

NOTES

[1] Intervals indicated are for normal service. For extreme conditions of speed, heat, water, mud, snow, rough roads, dust, etc., lubricate more frequently.

[2] Fittings.—Clean before applying lubricant. Lubricate after washing.

[3] Range rack and elevating screw pin.—Clean and apply OE daily.

[4] Wheel bearings.—Remove wheel, clean and repack bearings.

[5] Breech and firing mechanism.—Clean and oil all moving parts and exposed metal surfaces with OE daily. Perform operation before and after firing.

[6] Recoil slides and respirator.—Keep exposed surfaces coated with OE. Clean and oil before firing.

[7] Brake camshaft bearing—**Caution.**—Remove plug from brake camshaft housing, insert fitting, and apply OG sparingly.

[8] Oil can points.—Lubricate brake linkage, lunette hinge pin, apron hinges, handspike axle, handwheel handles, range scale shaft, and exposed compensator shafting with OE, weekly.

RA PD 4296

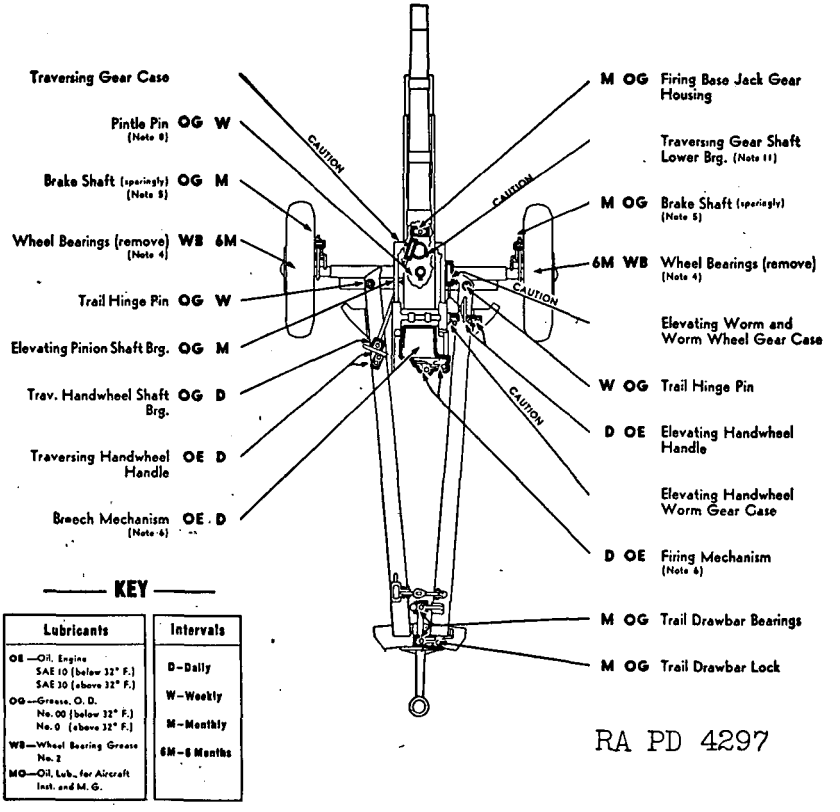


FIGURE 2.—Lubrication guide for 75-mm gun M2A1 and M2A2; carriage M1897A4.

NOTES

[1] Intervals indicated are for normal service. For extreme conditions of heat, water, mud, dust, etc., lubricate more frequently.

[2] Fittings.—Clean before applying lubricant. Lubricate after washing gun.

[3] Traversing and elevating racks and gears.—Clean and lubricate daily with OE.

[4] Wheel bearings.—Remove wheels, clean and repack bearings.

[5] Brake shaft.—**Caution.**—Remove plug from brake shaft housing, insert fitting and apply OG sparingly.

[6] Breech and firing mechanism.—Disassemble, clean and oil all moving parts immediately before and after firing, and daily at all other times. To avoid misfiring below freezing, remove firing mechanism, dip in *solvent, dry-cleaning,* and operate pin in solvent. Dry and lubricate with MO.

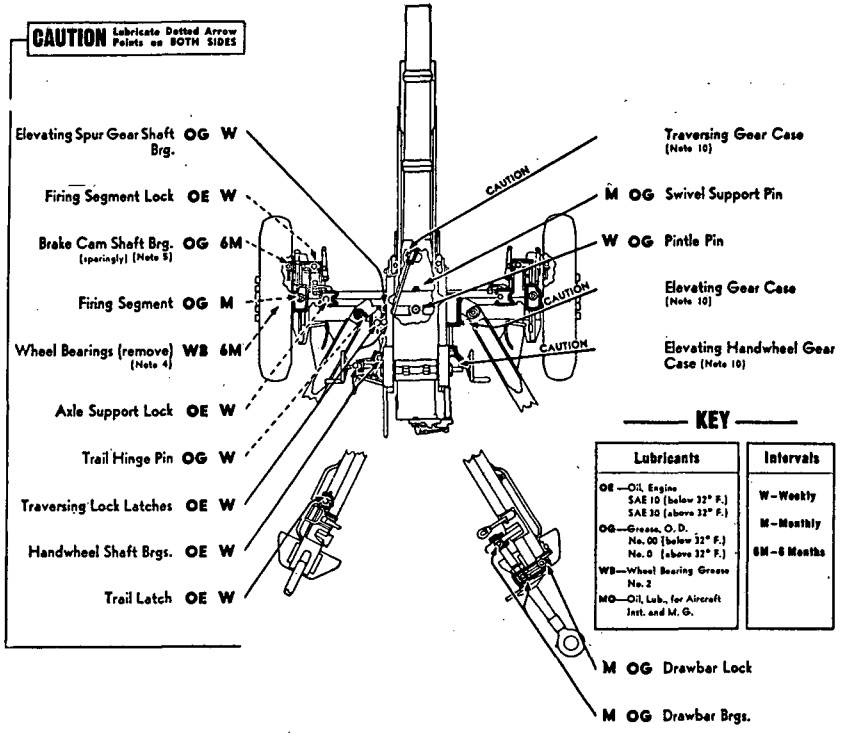
[7] Recoil slides.—Keep exposed surfaces coated with OE. Clean and oil before firing.

[8] Pintle pin.—To reach fitting, remove cover plate on rear of upper carriage.

[9] Gun bore.—Clean and coat bore with OE after firing. Inspect daily and oil if necessary.

[10] Oil can points.—Lubricate trail locking mechanism, hand brake catch and pawl, clevises, hinges, etc., with OE daily.

RA PD 4298



RA PD 4299

FIGURE 3.—Lubrication guide for 75-mm gun M2A3; carriage M1897A4.

NOTES

[1] Intervals indicated are for normal service. For extreme conditions of heat, water, mud, dust, etc., lubricate more frequently.

[2] Fittings.—Clean fittings and oilers before applying lubricant.

[3] Traversing and elevating racks and gears.—Clean and lubricate daily with OE.

[4] Wheel bearings.—Remove wheels, clean and repack bearings.

[5] Brake camshaft bearing.—**Caution.**—Remove plug from brake camshaft housing, insert fitting and apply OG sparingly.

[6] Recoil slides.—Keep exposed surfaces coated with OE. Clean and oil before and after firing.

[7] Breech and firing mechanism.—Disassemble, clean and oil all moving parts immediately before and after firing, and daily at all other times. To avoid misfiring below freezing, remove firing mechanism, dip in *solvent, dry-cleaning,* and operate pin in solvent. Dry and lubricate with MO.

[8] Gun bore.—Clean and coat bore with OE after firing. Inspect daily and oil if necessary.

[9] Oil can points.—Lubricate elevating and traversing handwheel handles, firing segment lock levers, brake lever ratchet release, etc., with OE daily. **Caution.**—Lubricate brake rod pins sparingly with OE monthly.

RA PD 4300

a. Soap, saddle.—(1) Used for cleaning leather equipment.

(2) The action of soap depends upon certain physical properties which help in bringing about the mechanical removal of dirt and grease. The soapy water in combination with the grease and dirt forms an emulsion which is easily washed off. Not much of the oil in the leather is removed by the soap since there is little or no chemical action. However, repeated washings will probably necessitate the replacement of oil to prevent the leather from becoming harsh and brittle, since some oil is removed each time the piece is washed.

(3) Nearly all ordnance leather equipment is russet leather. When it becomes soiled it should be cleaned by carefully removing all hardened grease with a sliver of wood (not glass or knife) and washing with a sponge saturated with a heavy lather of soap, saddle, and clean tepid water. Rinse thoroughly and rub vigorously with a dry cloth until the leather is dry. Straps and other articles of unvarnished harness leather which become dry and brittle should be cleaned as described, and while the leather is still slightly moist given an exceeding light coat of neat's-foot oil by rubbing with a soft cloth moistened (not saturated) with the oil. Wipe off any oil that the leather does not absorb. In cold weather the oil may be heated lukewarm (never hot) and the article after being oiled hung in a warm place. Shellacked sole leather cases do not require oiling.

(4) Russet leather as manufactured is stuffed with a dubbing of cod-liver oil and tallow which is absorbed to the extent that the quality of the leather is improved and its life prolonged, but not enough oil remains on the surface to soil the clothing if the equipment is properly cared for. It should be noted that in the washing and oiling described above if more than a light coat of oil is given, the leather will be greatly darkened and will quickly soil the clothing. No method of cleaning will then restore the original light color of the leather or remove stains from it.

(5) Articles of black leather may be cleaned with soap, saddle, rinsed, and when nearly dry, lightly sponged with a mixture of one teaspoonful of lampblack in 1 pint of neat's-foot oil, the mixture having been stirred first until it has a glossy black appearance. The mixture should then be well rubbed into the leather. Leather equipment which has become wet should be dried in the shade. Wet leather exposed to the sun or to too high a temperature from a stove or radiator becomes hard and brittle.

b. Sponges.—Used for washing and cleaning matériel. Natural sponges may be replaced by cellulose sponges in sizes Nos. 4, 6, 8, and

10 (approximate dimensions 1¼ by 3⅛ by 4⅝; 1⅝ by 3½ by 5¼; 2 by 3⅞ by 6¼; 2½ by 4⅝ by 6½). These latter sponges must not be wrung. Squeezing only is the proper method.

c. Waste, cotton (two grades, colored and white).—(1) The colored cotton waste is used for general cleaning purposes on the exteriors of ordnance matériel such as gun carriages and automotive vehicles. It is also used as calking for cracks from which it is desired to exclude dust and dirt.

(2) White waste is used for general cleaning purposes on finished surfaces of ordnance matériel. In lieu of white cotton waste an equivalent amount of clean wiping cloths may be used.

39. Preservatives.—See *TM 9–850 for information on rust, corrosion, inspection for corrosion, rust preventives, preparation of metal surfaces for slushing, method of slushing, inspection of grease films, and storage conditions.

a. Naphthalene, flake.—(1) A flaked form of mothball.

(2) Used as a moth repellant to preserve felt wads, felt packings of instrument chests, gun sponges, and paint and varnish brushes. It is sprinkled thickly on the articles, which should if possible be then wrapped in paper covers and tightly boxed. The matériel should be thoroughly brushed and aired before packing and should be periodically inspected. If there are any signs of devastation by the moth larvae, the articles must be unpacked, cleaned, and recharged with naphthalene.

b. Naphthalene should be used in airtight receptacles in order to obtain a concentrated naphthalene vapor.

40. Paint and related materials.

Lacquer.
Lead.
Lead, red, dry.
Lead, white, basic carbonate (or basic sulfate), paste.
Mixture, liquid (for red lead paint).
Oil, linseed, raw.
Enamel, red, water-resistant.
Enamel, synthetic, olive-drab, lusterless.
Enamel, white.
Putty (whiting).
Stencil, black.
Stencil, white.
Shellac, orange.

*See list of references (appendix).

Thinner (for olive-drab lusterless enamel).
Turpentine.
Varnish, shellac, orange.
Varnish, spar, water-resistant.

a. Oil paints and their application.—(1) Paint is used for preservation against rust, deterioration and decay of metals and woods. Some paints adhere to metal surfaces better than others, the liquids of the first or base coat seeming to penetrate very minute depressions or pits in the metal or to etch themselves into the surface and thus form a good bond for following coats. The paints are issued mixed and ready to apply except in a few instances. Paint stored in large containers should be well stirred before transfer to smaller containers. Ordnance matériel is well painted before issue and one maintenance coat per year should be ample for protection.

(2) Red lead paint is a good base coat on iron or steel. Red lead possesses no particular advantages as a base coat on nonferrous metals. Red lead paint does not keep well and must be mixed as needed. The formula for 1 gallon of it is 20 pounds of dry red lead with 3 quarts of liquid mixture. The usual process of mixture is to place a small amount of dry red lead in a suitable container, work a little of the mixture into it to form a paste, and then stir the rest of the liquid mixture into it.

(3) The standard olive-drab lusterless synthetic enamel is issued mixed for a finishing coat. This enamel may be applied over long oil enamel or oil paint. Method of application may be by brush or spray. It may be brushed on satisfactorily when used unthinned in the original package consistency; or when thinned no more than 5 percent of the volume with thinner. The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner. If sprayed, it dries hard enough for repainting within ½ hour. It dries hard in 16 hours. Linseed oil must not be used as a thinner for this enamel.

(4) For use on woodwork a sanding filler over the primer is required. The sanding filler is a ready-mixed semipaste but when thinned with 50 percent turpentine by volume has good brushing, covering, and leveling qualities. These fillers dry in approximately 8 hours.

(5) Care must be used in preparing the surface for painting. It should be made thoroughly clean, dry, and smooth.

(6) All paints should be well stirred before using. If too thick, turpentine should be used as a thinner, but not to such an extent that the paint does not cover. The exact and proper thickness of

each coat can be learned only by experience. If too thin, it often cracks in drying, and if too thick it becomes blistered, wrinkled, and uneven. The first coat may however be much thinner than any of the succeeding coats.

(7) Parts to be painted may be washed in a liquid solution of ½ pound of soda ash in 8 quarts of warm water, then rinsed in clean water, and wiped thoroughly dry.

(8) When artillery is in fair condition and only marred in spots, the marred places should be touched with enamel or paint and permitted to dry. The whole surface should then be sandpapered with No. 1 flint paper and repainted with a finish coat and allowed to dry thoroughly before use.

(9) When matériel is in bad condition, all parts should be thoroughly sandpapered with No. 2 flint paper, given a coat of enamel or olive-drab second-coat paint, and permitted to dry. It should then be sandpapered with No. 00 flint paper. Finally apply a finishing coat and permit the parts to dry thoroughly before use.

(10) After repeated paintings the paint may become so thick as to scale off in places or present an unsightly appearance. It may then be removed by use of a lime-and-lye solution on metal parts, or paint and varnish remover or cleaning compound on wood parts. It is important that every trace of lye, remover, or cleaning compound be rinsed off. In addition to the cleaning, woodwork should be properly putty-stopped after priming coat and before second coat is applied.

(11) Oil cups, grease gun fittings, spring oil hole covers, and similar lubricating devices, as well as a spot ¾ inch in diameter around each oil hole, are painted red so that they may be readily located.

(12) At the the conclusion of a painting job, the brushes must be carefully washed clean with dry-cleaning solvent and kept in water, except that camel's-hair brushes, after thorough cleaning, should be laid flat on a shelf or other convenient, clean surface in order that the hair may not be distorted. Worn paint brushes should be retained for use in spreading rust-preventive compounds. Any usable paint remaining in the paint pot should be kept tightly covered.

b. Lacquer.—A rapidly drying and very transparent liquid. Sets to touch in 3 minutes. Used on sandblasted metal surfaces of fire-control and sighting equipment because of its transparency and to prevent tarnishing and deterioration. The lacquer, which must be thin enough to flow easily, is applied with a camel's-hair brush. Alcohol may be used as a thinner but only when absolutely necessary.

c. Lead.—(1) *White, basic sulphate or carbonate, paste.*—Used as an extra heavy rust-preventive coating on exposed metallic surfaces. Various materials have been used to reduce the stiff lead paste to a more plastic and workable material. Since freedom from corrosive elements is desired, rust-preventive compound is preferable to lubrication oil for this purpose. Melted tallow is sometimes used. The white lead coating may be used for preservation of matériel in stand-by condition, the idea being that it is more adhesive under extremes of temperature than rust-preventive compound. It should not be used on intricate working surfaces where it cannot be readily removed without damaging those surfaces.

(2) *Red, dry.*—(*a*) Separate requisition is required for the necessary liquid mixture for making red lead paint.

(*b*) Red lead paint is used as a base coat on iron and steel nonbearing parts of ordnance matériel. It has the effect of slightly etching the surface and so secures a good bond for succeeding coats.

d. Mixture, liquid, for red lead paint.—Used for mixing red lead paint.

e. Oil, linseed, raw.—Used as an auxiliary thinner for ready-mixed paint. As a thinner add small quantities of the raw oil at a time, stirring constantly until the paint flows freely under the brush.

f. Enamel, red, water-resistant.—Used around oil holes and fittings for lubricants to attract attention and furnish ready identification. Also for target marking disks and aiming posts.

g. Enamel, white.—Used on aiming posts.

h. Enamel, synthetic, olive-drab, lusterless.—Used for painting all types of ordnance matériel unless otherwise specifically excepted.

i. Stenciled, black.—Used for stenciling equipment and matériel, except on black background.

j. Stencil, white.—Used for stenciling equipment and matériel, except on white background

k. Shellac, orange.—Used for finishing inside of wooden chests.

41. Lubricants.

Oil, engine, SAE 10.
Oil, engine, SAE 30.
Grease, O. D., No. 0.
Grease, O. D., No. 1.
Grease, wheel bearing, No. 2.
Oil, lubricating, for aircraft instruments and machine guns.

a. Oil, engine, SAE 10.—Used when temperature is below 32° F., on gun slides, breechblocks (see *f* below), racks, unpainted parts, etc., of artillery, and unless otherwise prescribed, for general lubricating purposes in winter weather.

b. Oil, engine, SAE 30.—Used when temperature is 32° F. or above, on gun slides, breechblocks, racks, unpainted parts, etc., of artillery and, unless otherwise prescribed, for general lubricating purposes in summer weather.

c. Grease, O. D., No. 0.—Used in compression grease cups, pressure lubricating fittings, etc., for temperatures below 32° F. Grease, O. D., No. 0, is also used in gear cases which are not sealed.

d. Grease, O. D., No. 1.—Used in compression grease cups, pressure lubricating, etc., for temperatures above 32° F.

e. Grease, wheel bearing, No. 2.—Required for carriage wheel bearings which incorporate in their design antifriction bearings.

f. Oil, lubricating, for aircraft instruments and machine guns.—Used for lubricating the breech and firing mechanism in extremely cold weather (below 10° F.) and to lubricate delicate bearings of fire-control and sighting instruments. In *oiling fire-control instruments*, only a few drops are needed. If more than necessary is used, it may run into the optical elements of the instrument and so affect the serviceability of the instrument as to require complete disassembly to remove the oil. The oil is applied by dropping from the dropper attached to the bottle stopper or from the end of a piece of wire.

42. Miscellaneous materials and tools.—For the purposes for which used, see *TM 9–850. Articles are—

Brushes:
- Mottling, No. 2 (⅞ inch).
- Artist's, camel's-hair, round, No. 1 (⅛ inch).
- Artist's, camel's-hair, round, No. 5 (¼ inch).
- Duster, painter's, round (2½ inches).
- Sash tool, oval, No. 1 (27/32 by 1¾ inches).
- Sash tool, oval, No. 3 (1 3/32 by 2⅛ inches).
- Scratch, painter's, handled (14 by ⅞ inches).
- Varnish, oval (1⅞ inches).

Knife, putty.
Needle, sacking.
Palm, sailmaker's.
Twine, jute.

NOTE.—*Care of brushes.*—Bristles of brushes are subject to attack by moths. Brushes in storage should be protected by naphthalene.

*See list of references (appendix).

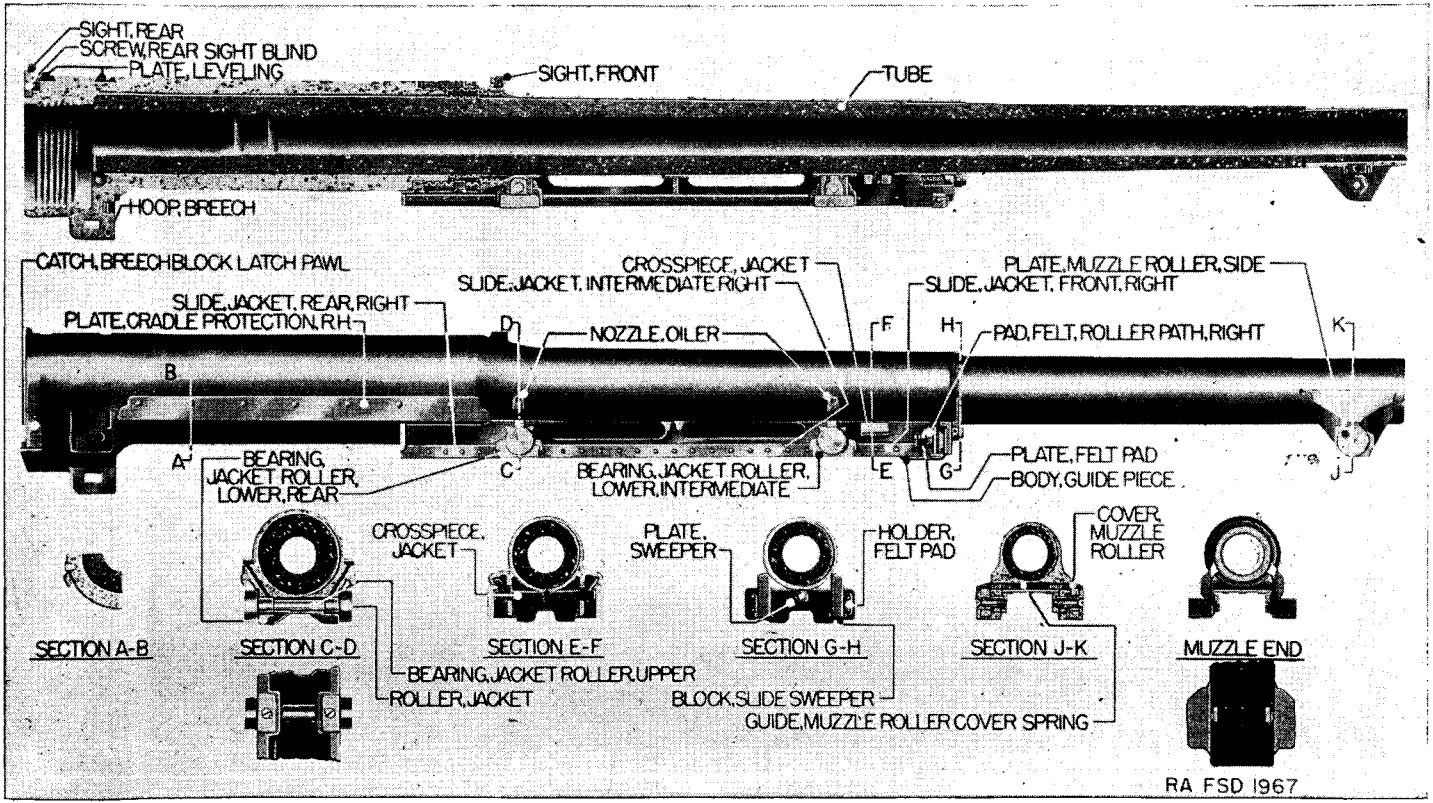


FIGURE 4.—75-mm gun M1897, sectional view.

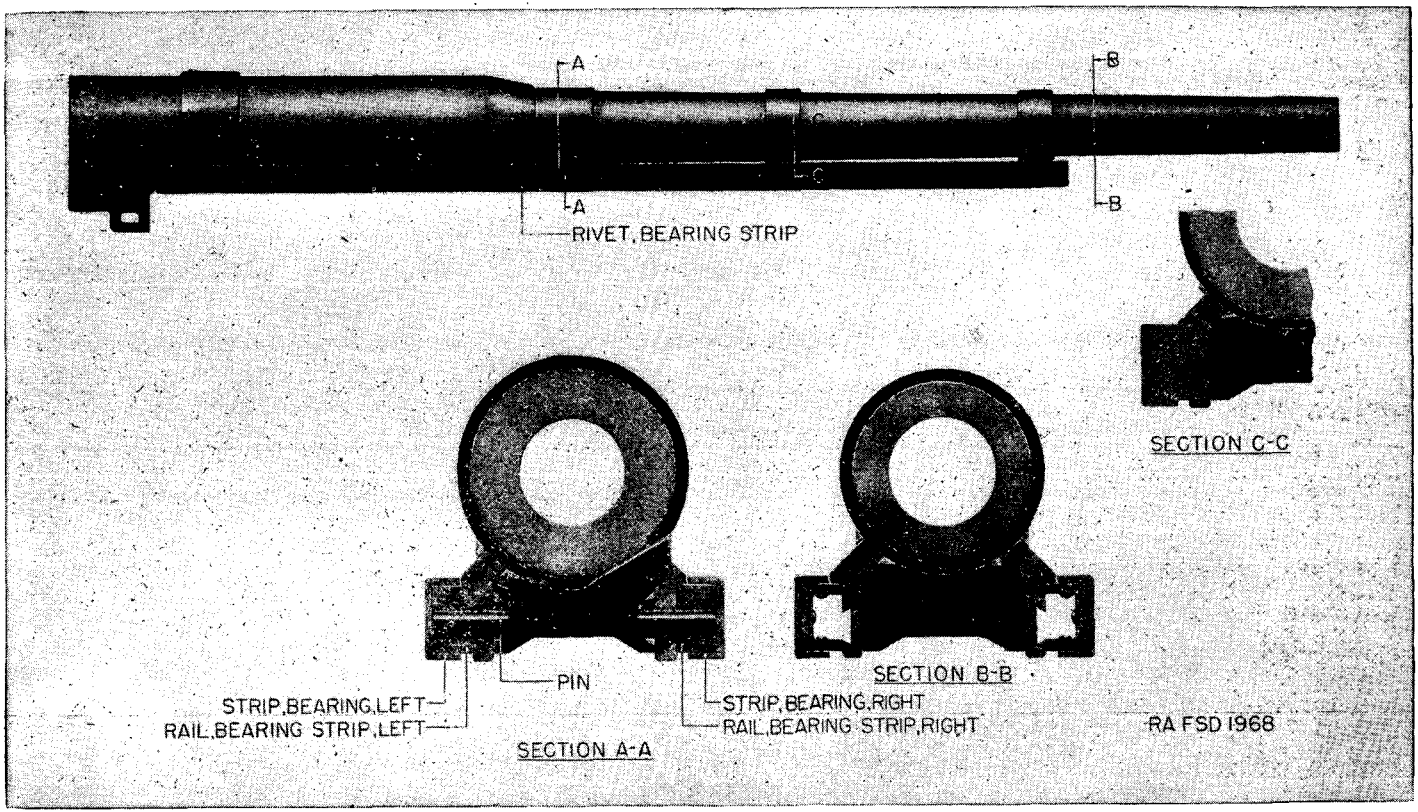


FIGURE 5.—75-mm gun M1897A4.

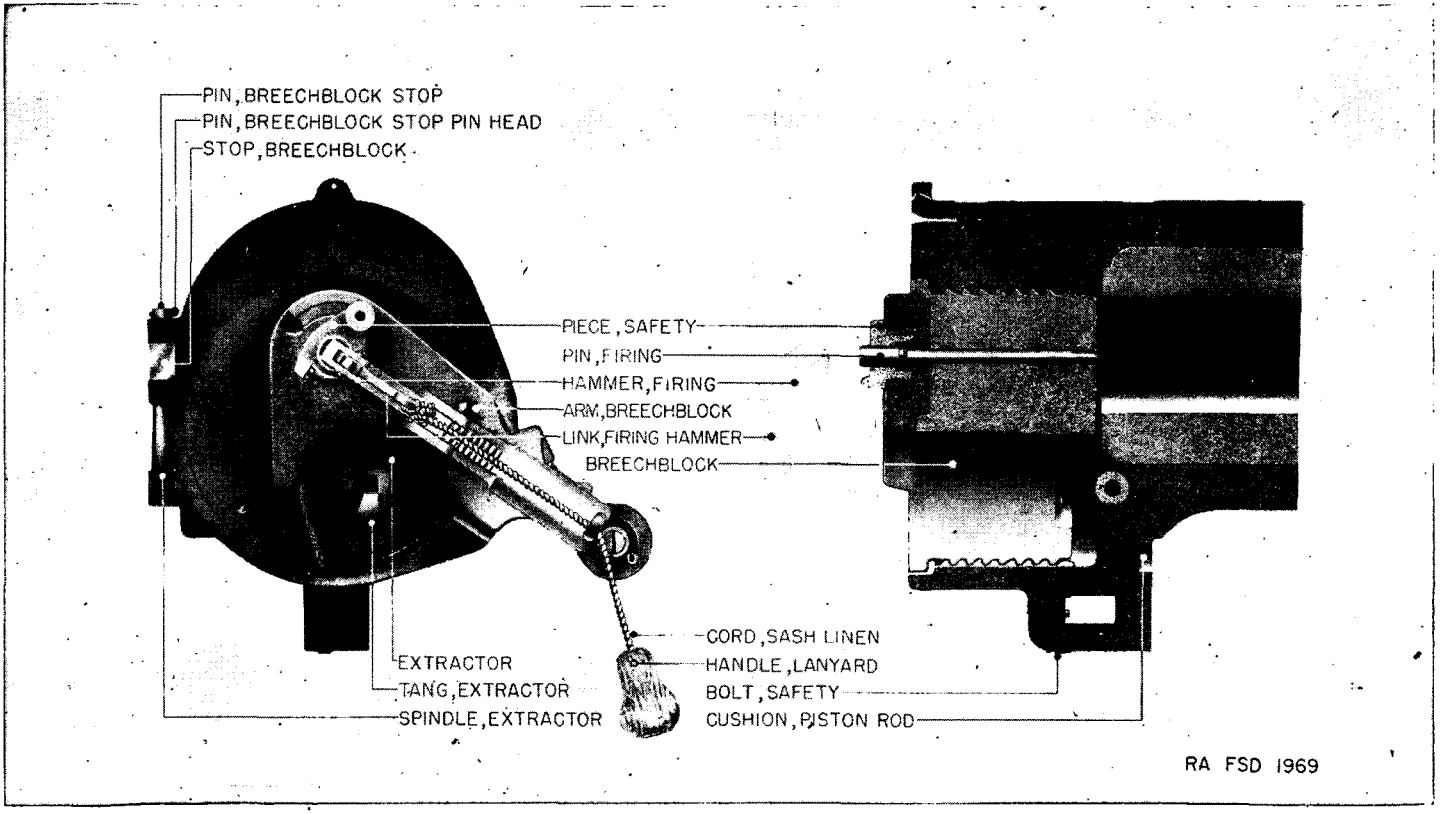


FIGURE 6.—Breech mechanism assembly and sections.

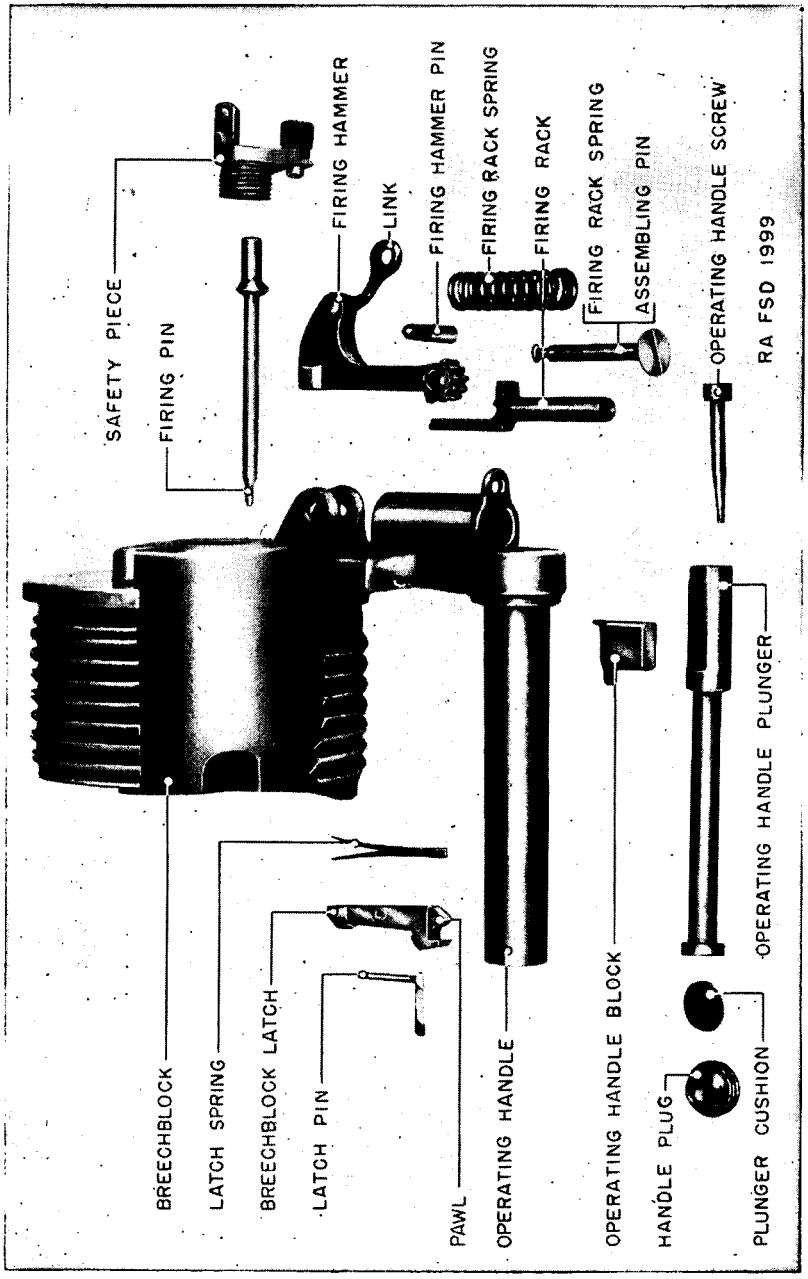


FIGURE 7.—Breechblock and parts.

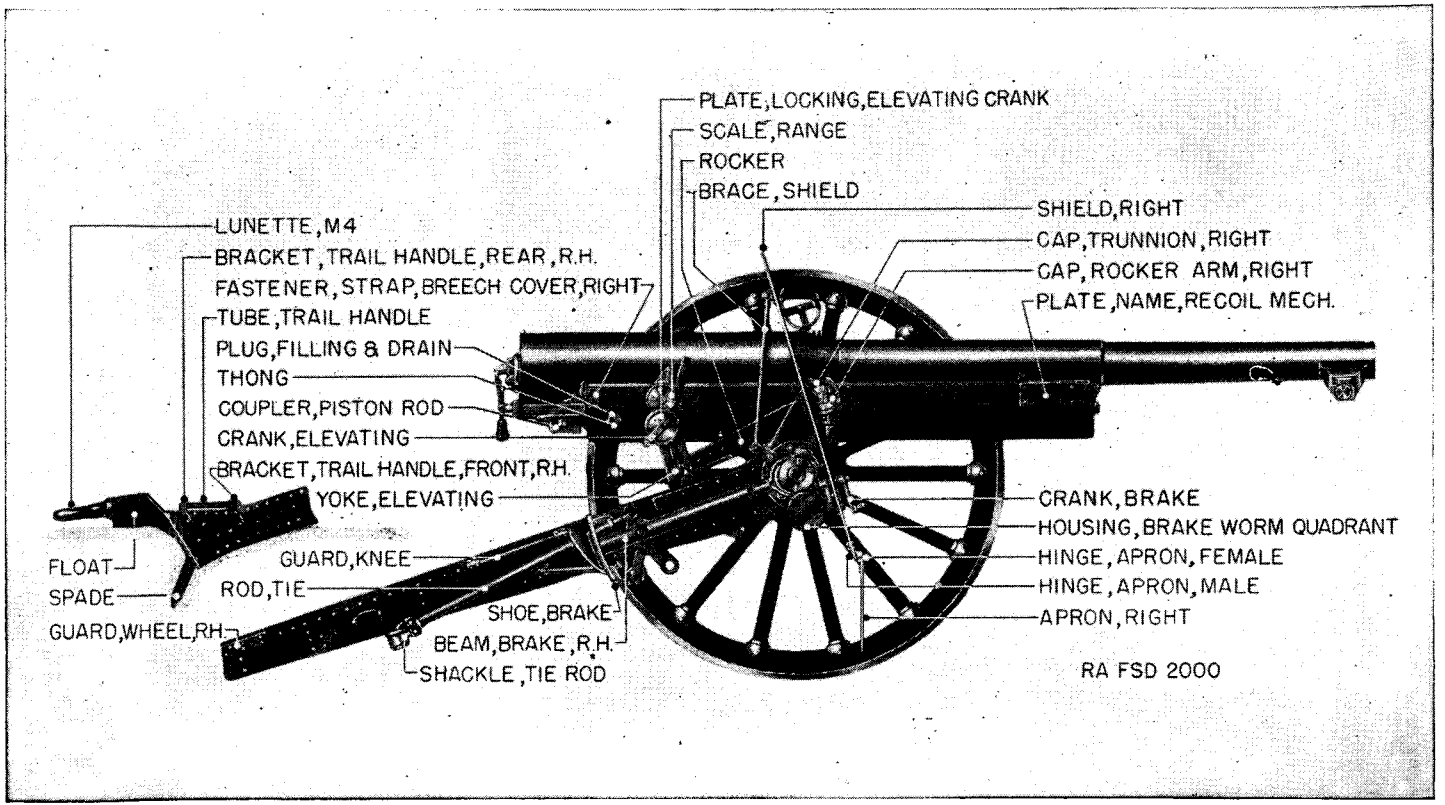


FIGURE 8.—75-mm gun carriage M1897, right side.

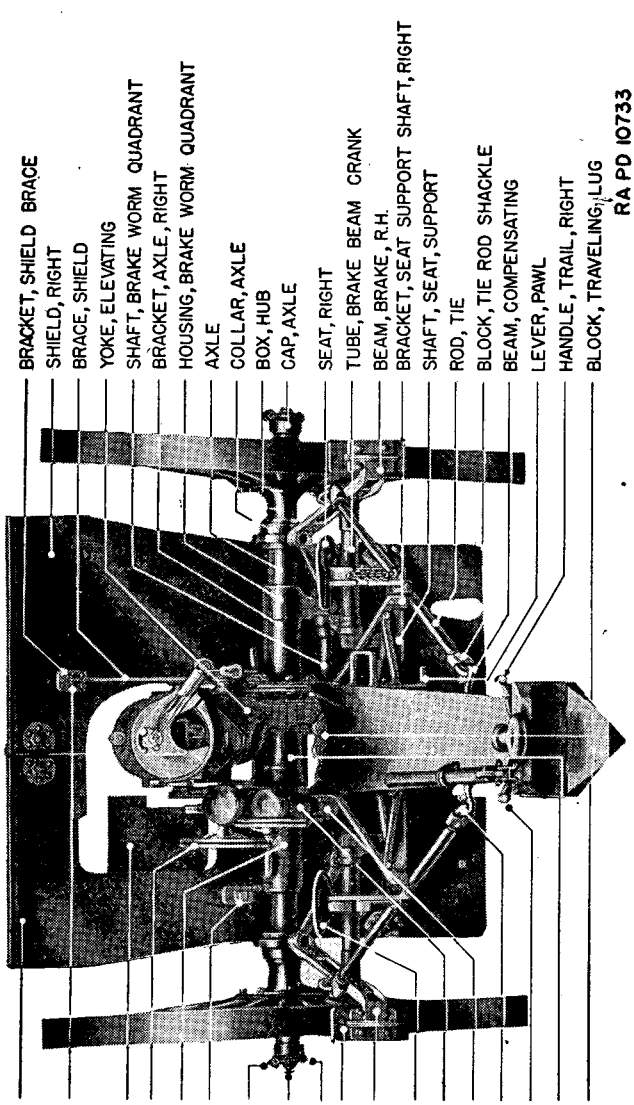


FIGURE 9.—75-mm gun carriage M1897M1A2, rear view.

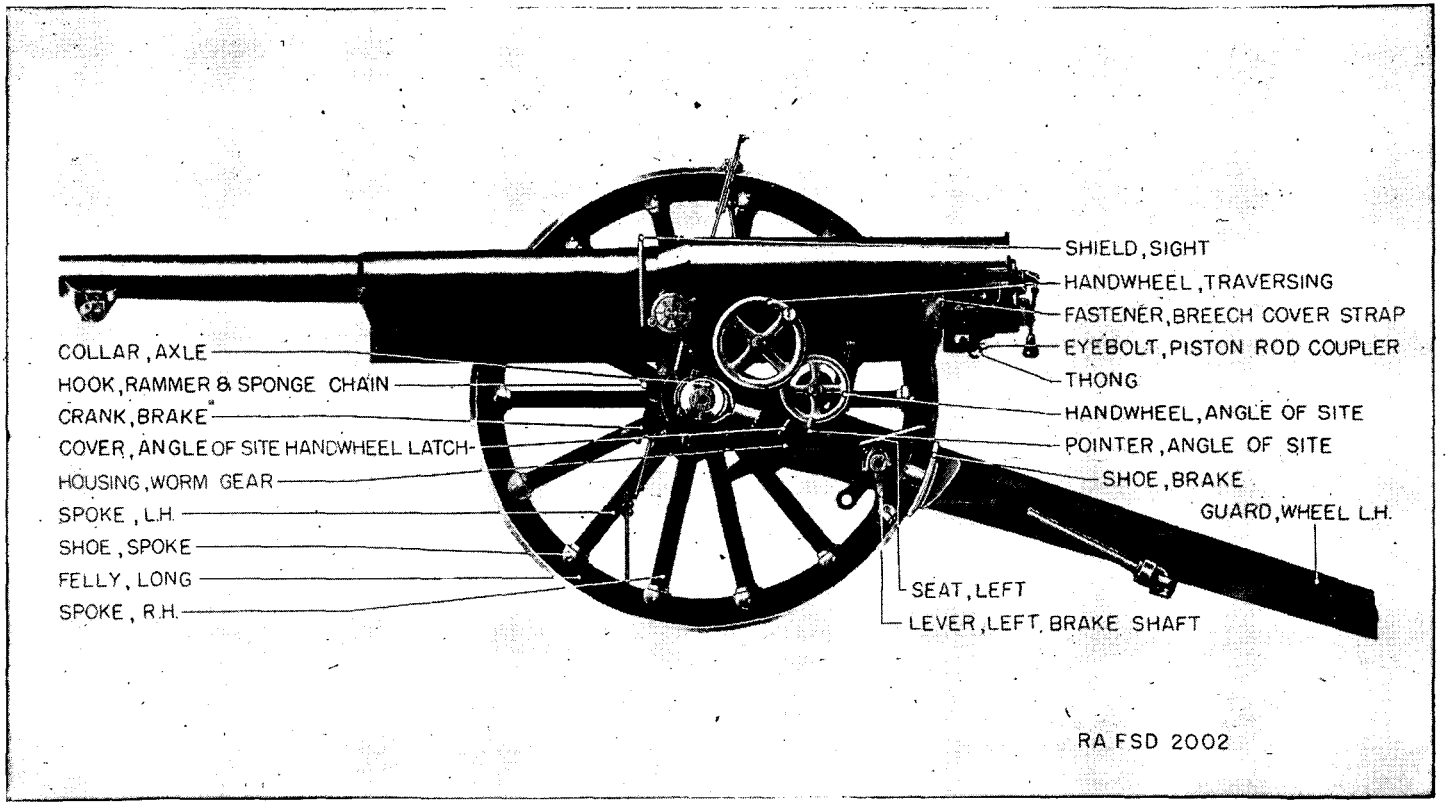


FIGURE 9.—75-mm gun carriage M1897MIA2, rear view.

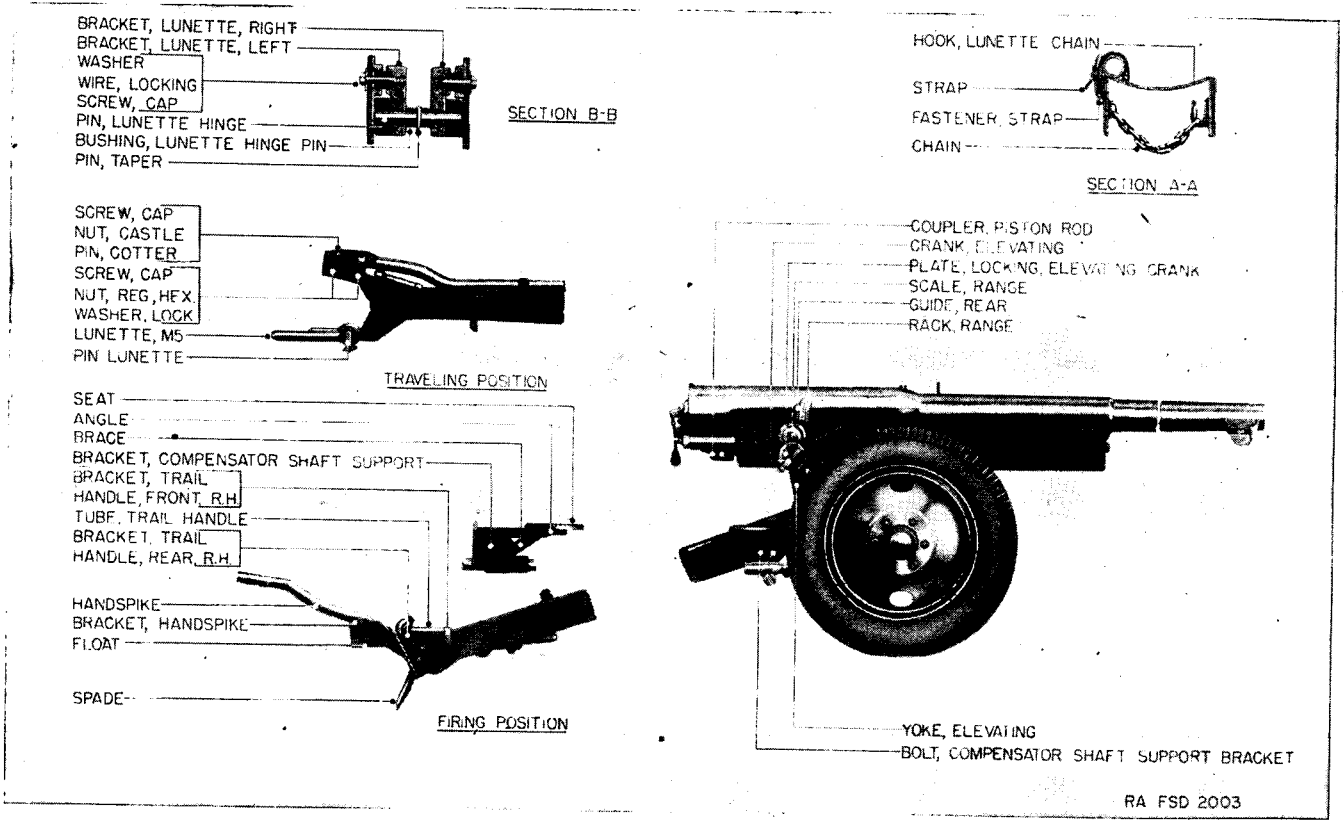


FIGURE 11.—75-mm gun carriage M1897A4, right side.

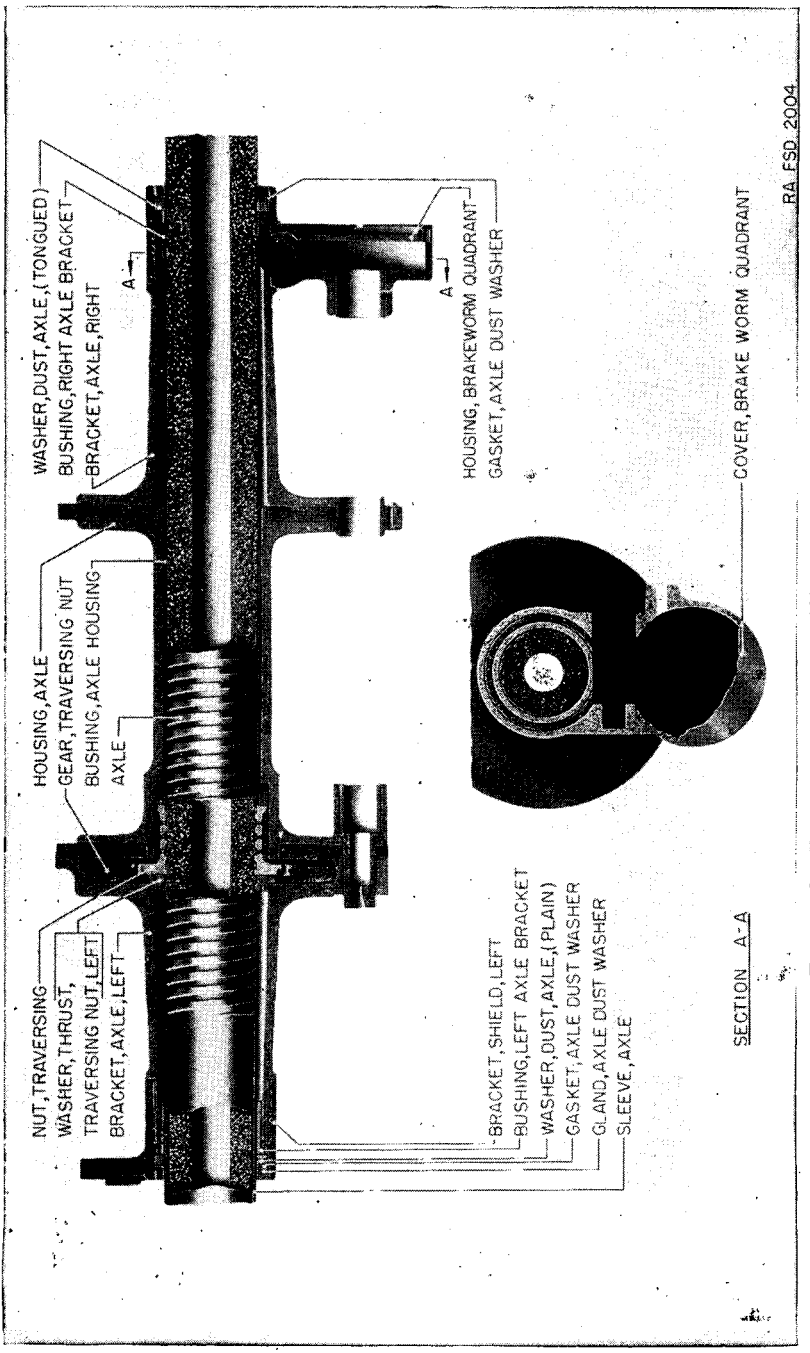
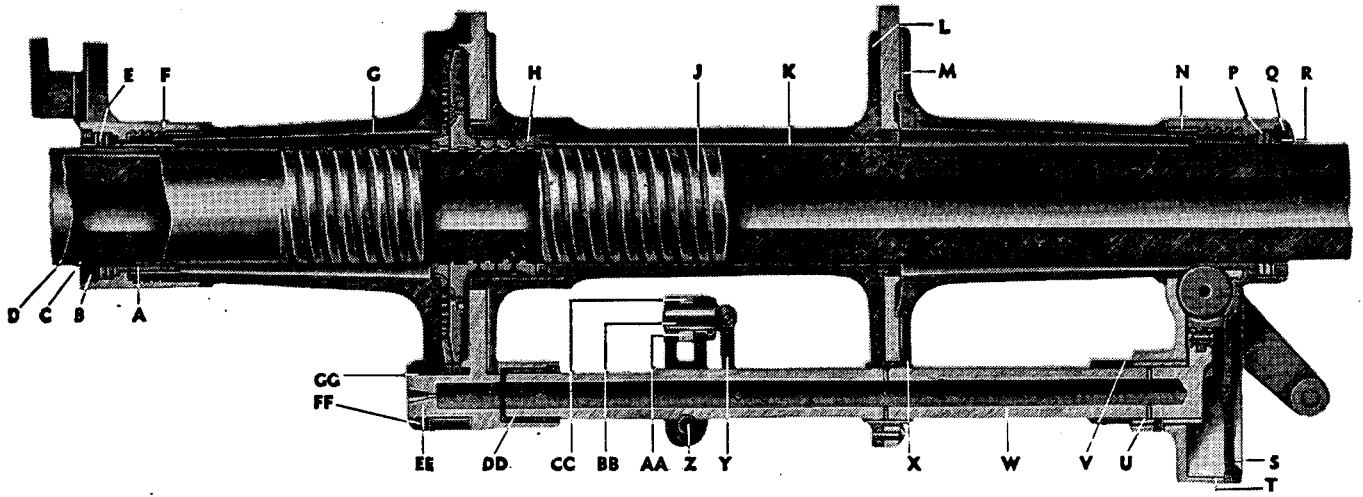


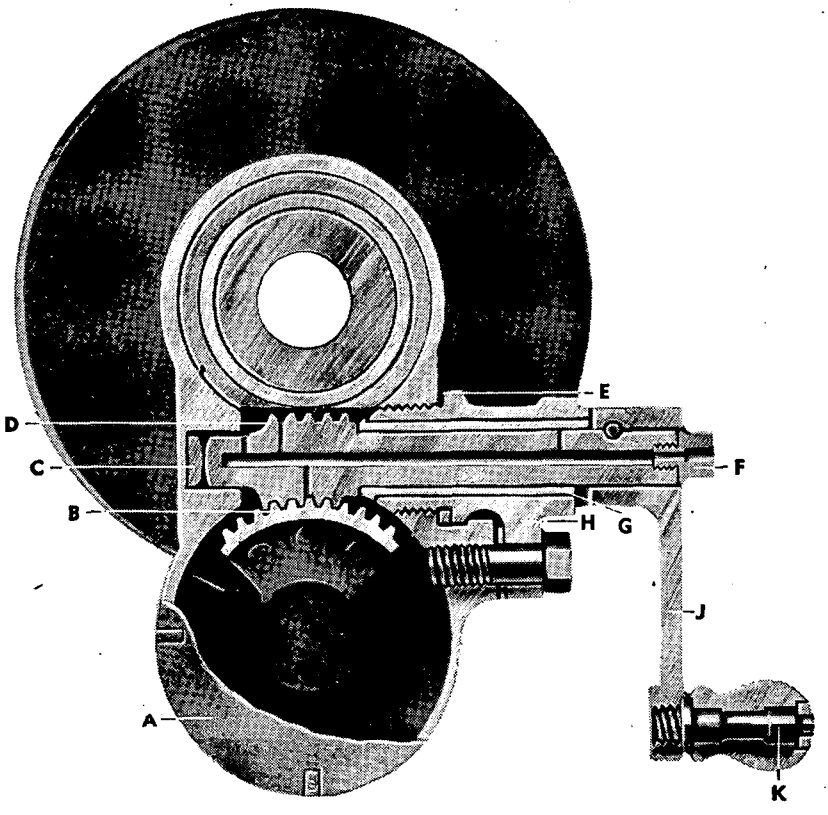
FIGURE 12.—Traversing mechanism M1897A4, assembled views.



A — BUSHING, LEFT AXLE BRACKET
B — GLAND, AXLE DUST WASHER
C — GASKET, AXLE DUST WASHER
D — SLEEVE, AXLE, ASSEMBLY
E — WASHER, DUST, AXLE
F — BRACKET, SHIELD, LEFT
G — BRACKET, AXLE, LEFT, ASSEMBLY
H — NUT, TRAVERSING, ASSEMBLY
J — AXLE, ASSEMBLY
K — BUSHING, AXLE HOUSING
L — HOUSING, AXLE, ASSEMBLY
M — BRACKET, AXLE, RIGHT, ASSEMBLY
N — BUSHING, RIGHT AXLE BRACKET
P — WASHER, DUST, AXLE
Q — GLAND, AXLE DUST WASHER
R — GASKET, AXLE DUST WASHER
S — COVER, BRAKE WORM QUADRANT
T — HOUSING, BRAKE WORM QUADRANT, ASSEMBLY
U — BUSHING, BRAKE WORM QUADRANT SHAFT, RIGHT
V — COLLAR, BRAKE WORM QUADRANT SHAFT
W — SHAFT, BRAKE WORM QUADRANT, ASSEMBLY
X — BEARING, BRAKE WORM QUADRANT SHAFT
Y — FORK, BRAKE STRAP FRONT LEVER PIN
Z — BOLT, BRAKE STRAP LEVER CLAMP
AA — LEVER, BRAKE STRAP, FRONT
BB — PIN, BRAKE STRAP FRONT LEVER
CC — HEAD, BRAKE STRAP
DD — BUSHING, BRAKE WORM QUADRANT SHAFT, LEFT
EE — SOCKET, BRAKE WORM QUADRANT SHAFT, ASS'Y
FF — NUT, BRAKE WORM QUADRANT SHAFT SOCKET, ASSEMBLY
GG — COVER, BRAKE WORM QUADRANT SHAFT SOCKET NUT, ASSEMBLY

RA PD 10734

FIGURE 13.—Traversing and brake operating mechanism M1897MIA2, assembled views.



A — COVER, BRAKE WORM QUADRANT
B — QUADRANT
C — BLOCK, THRUST, BRAKE WORM
D — WORM, BRAKE
E — WASHER, BRAKE WORM SUPPORT
F — NOZZLE, BRAKE WORM OILER
G — BUSHING, BRAKE WORM SUPPORT
H — SUPPORT, BRAKE WORM ASSEMBLY
J — CRANK, BRAKE ASSEMBLY
K — SPINDLE, BRAKE CRANK HANDLE

RA PD 10735

FIGURE 13.—Traversing and brake operating mechanism M1897MIA2, assembled views—Continued.

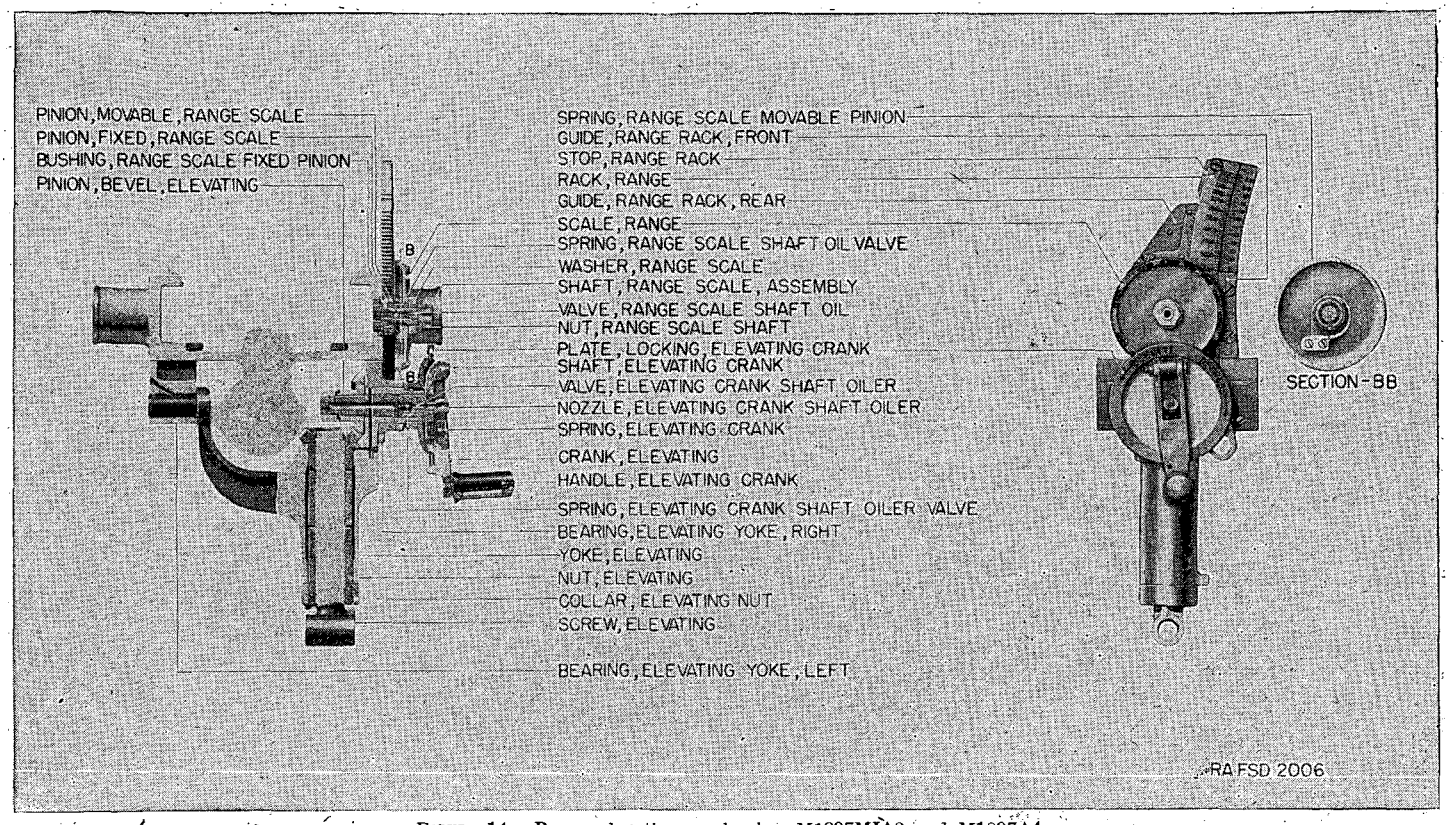


FIGURE 14.—Range elevation mechanism M1897MIA2 and M1897A4.

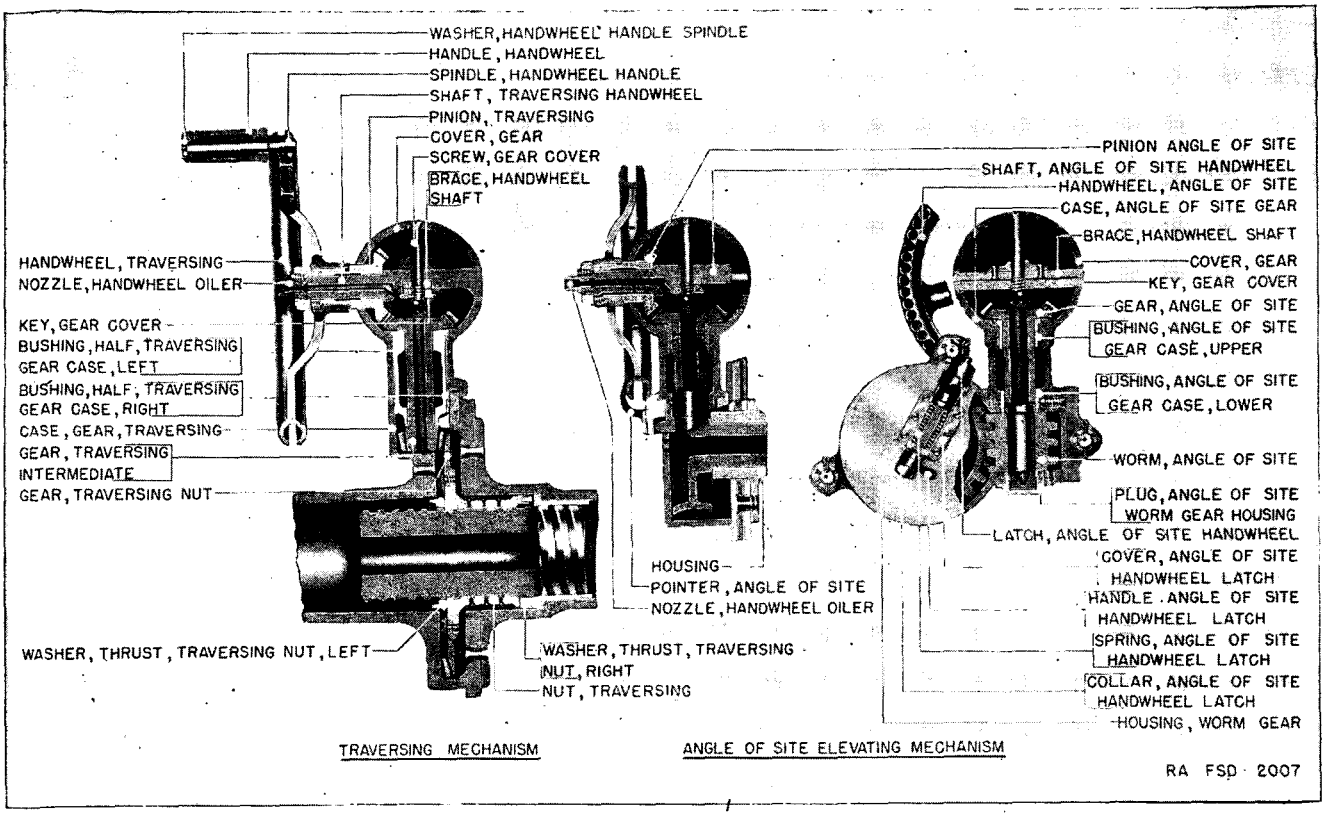


FIGURE 15.—Traversing and angle of site mechanism M1897MIA2 and M1897A4, assembled views.

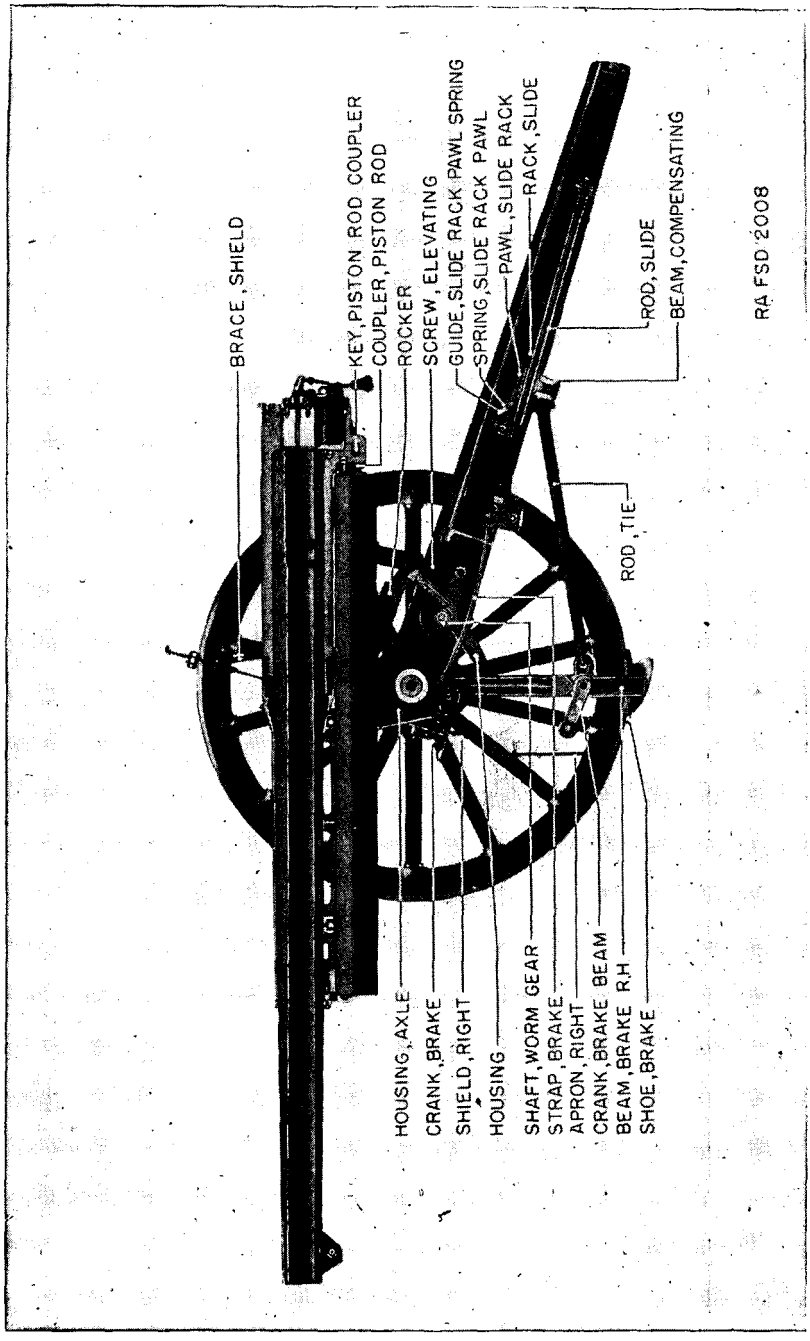


FIGURE 16.—75-mm gun carriage M1897M1A2, longitudinal section.

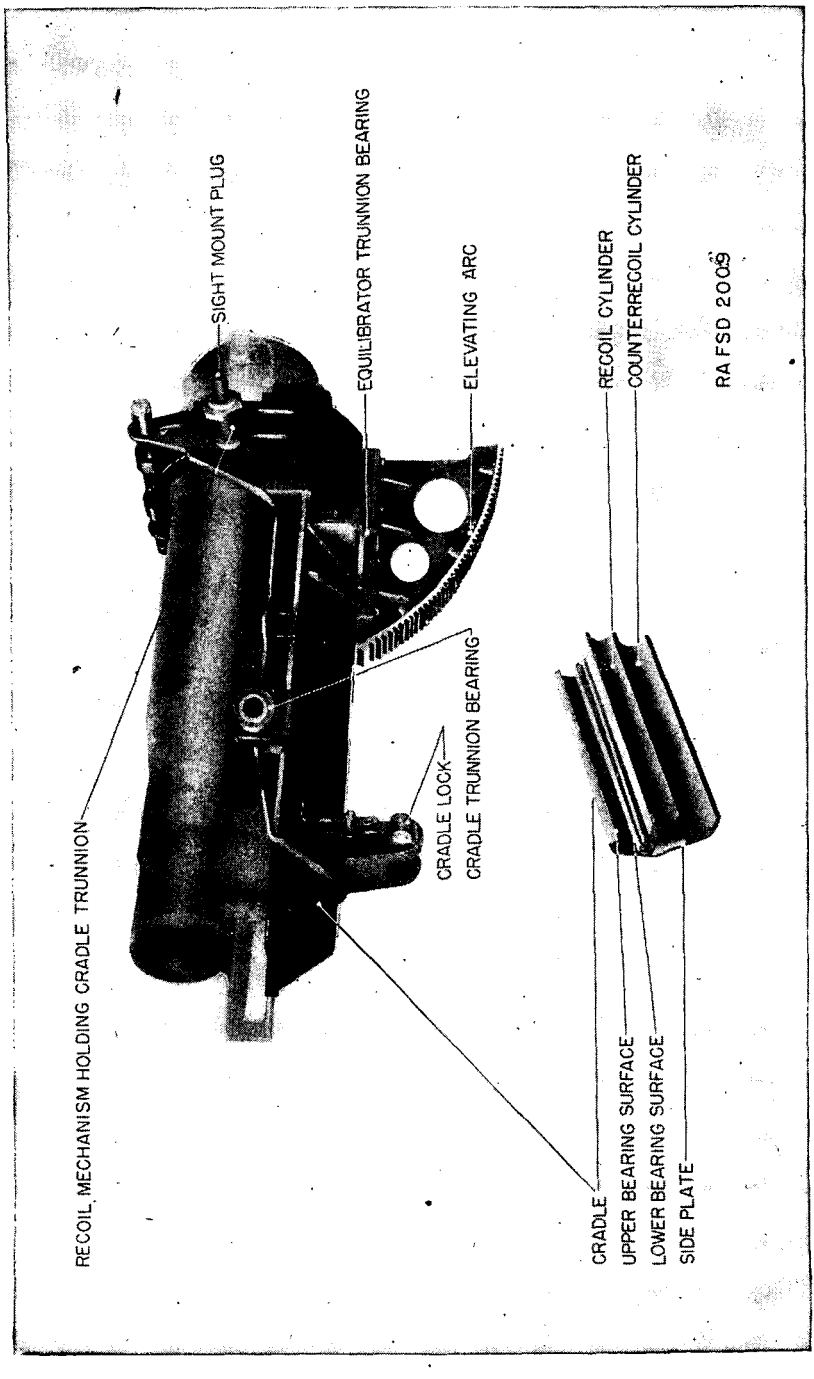


FIGURE 17.—Cradle and recoil holding mechanism M2A2.

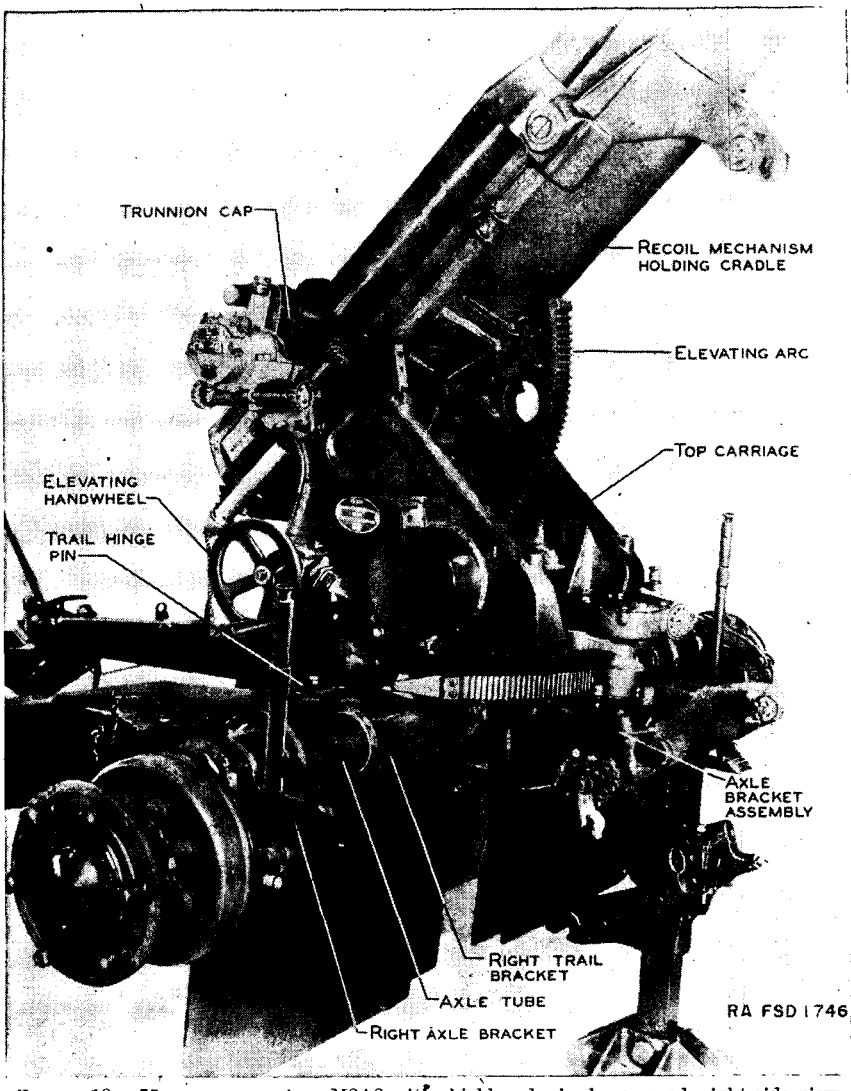


FIGURE 18.—75-mm gun carriage M2A2 with shield and wheels removed, right side view.

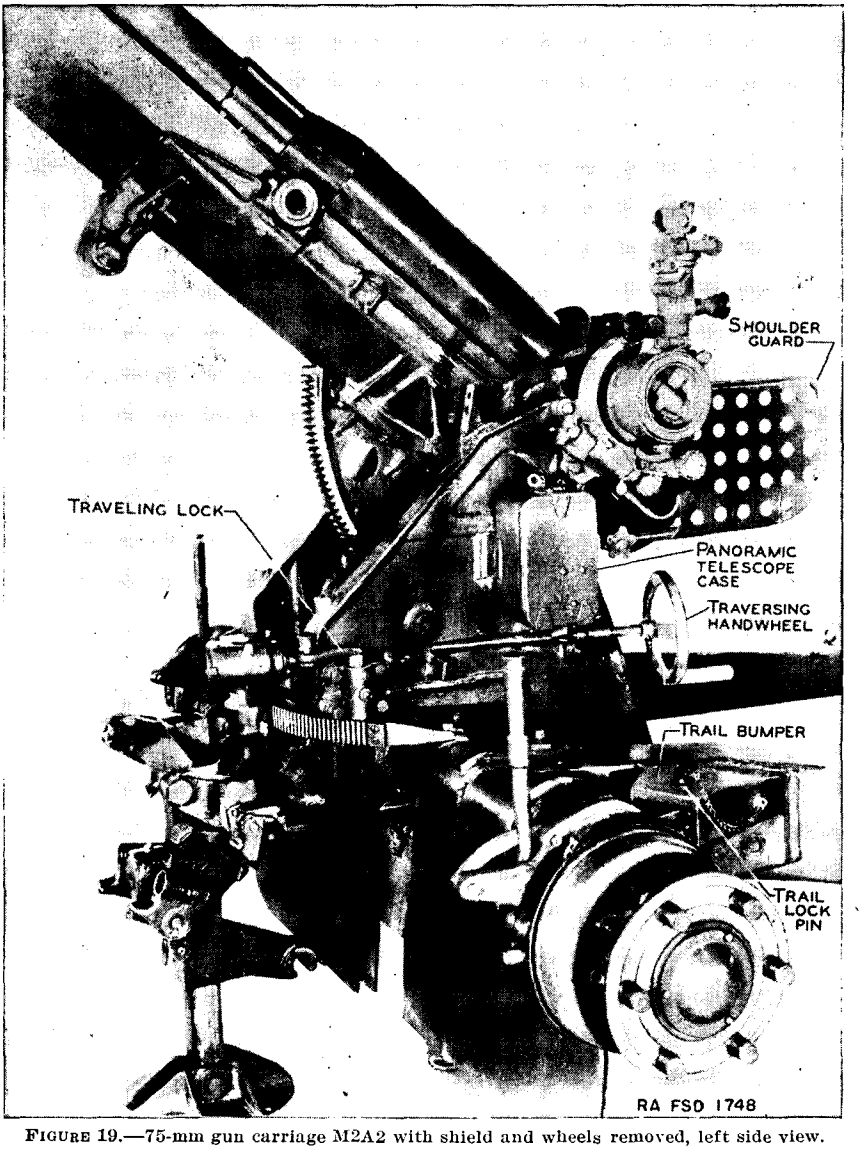


FIGURE 19.—75-mm gun carriage M2A2 with shield and wheels removed, left side view.

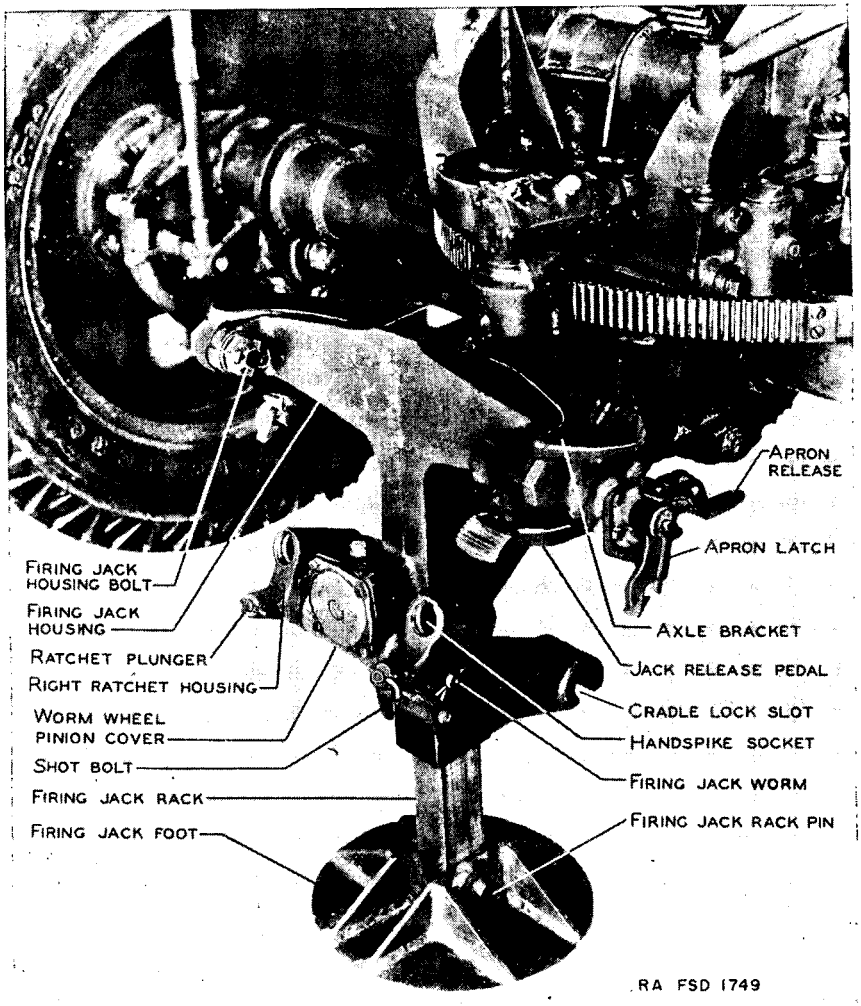


FIGURE 20.—Firing jack.

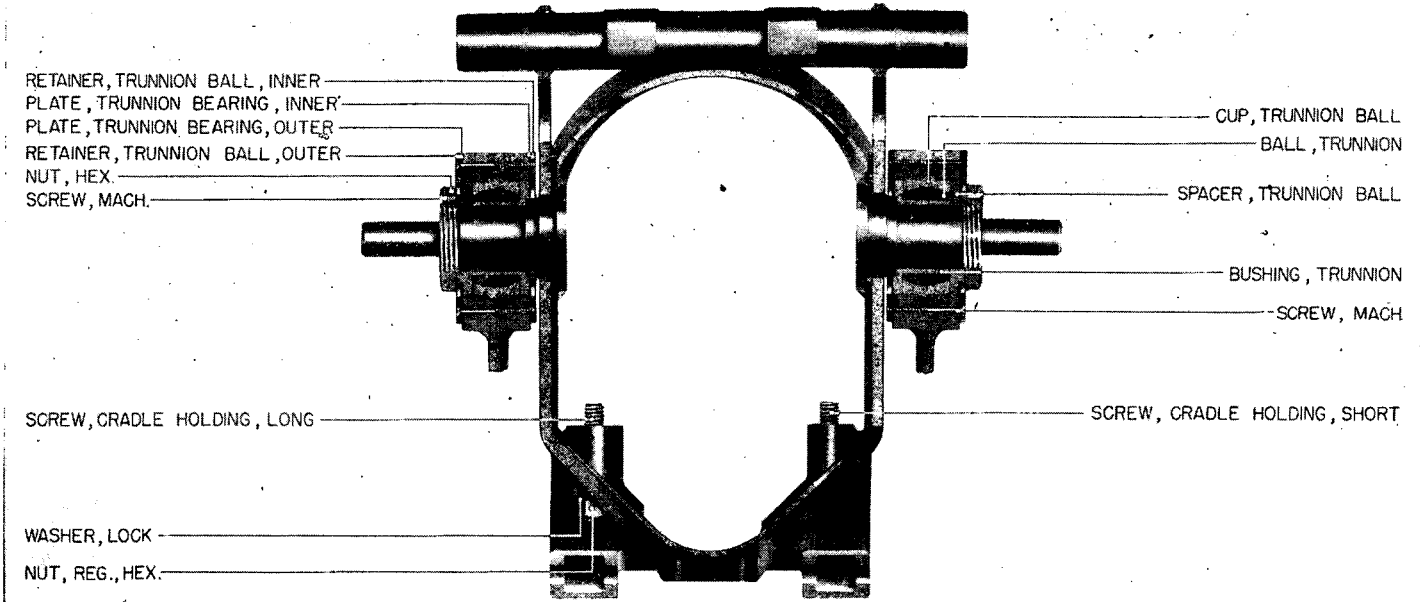


FIGURE 21.—Trunnions M2A2.

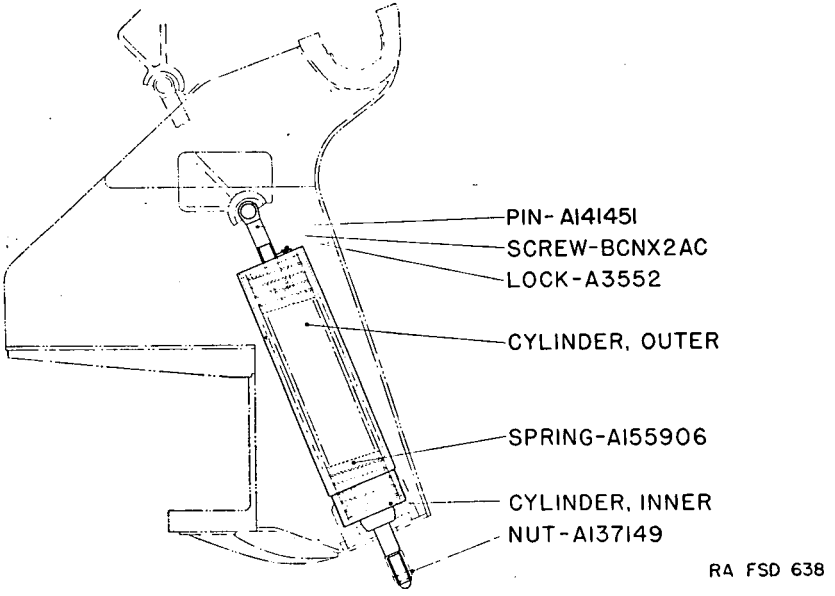
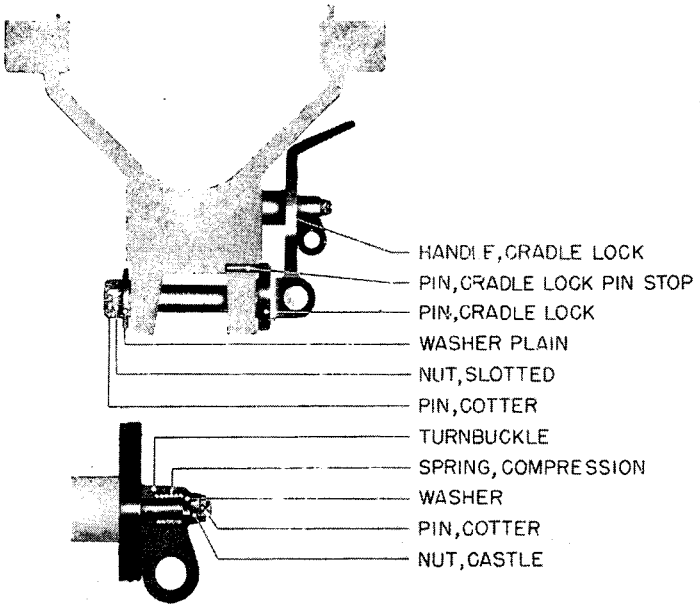


FIGURE 22.—Equilibrator.



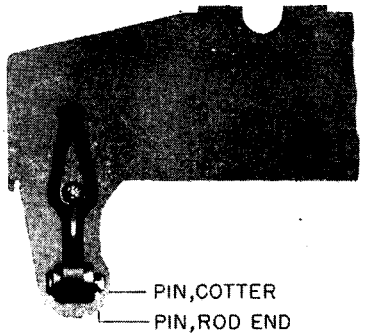


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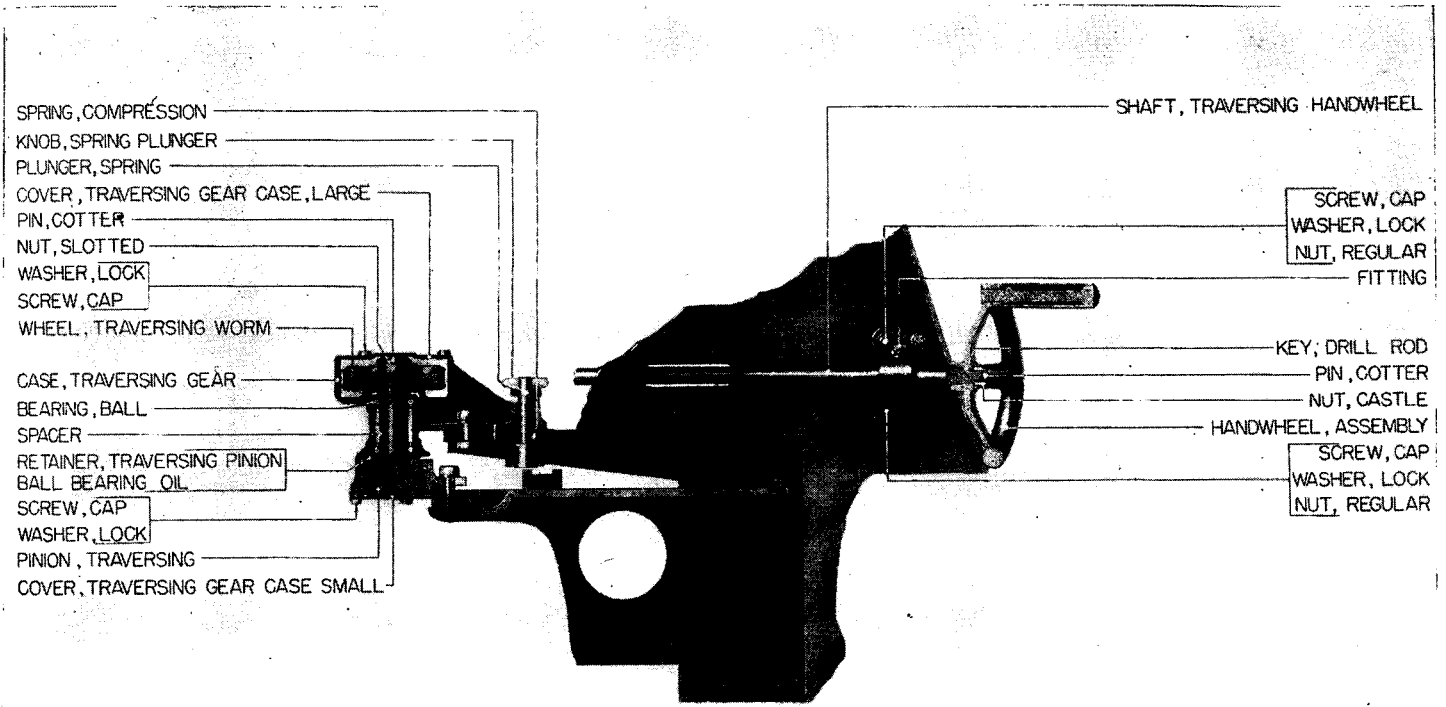
FIGURE 23.—Lock M2A2.


SPRING, COMPRESSION
KNOB, SPRING PLUNGER
PLUNGER, SPRING
COVER, TRAVERSING GEAR CASE, LARGE
PIN, COTTER
NUT, SLOTTED
WASHER, LOCK
SCREW, CAP
WHEEL, TRAVERSING WORM
CASE, TRAVERSING GEAR
BEARING, BALL
SPACER
RETAINER, TRAVERSING PINION BALL BEARING OIL
SCREW, CAP
WASHER, LOCK
PINION, TRAVERSING
COVER, TRAVERSING GEAR CASE SMALL
SHAFT, TRAVERSING HANDWHEEL
SCREW, CAP
WASHER, LOCK
NUT, REGULAR
FITTING
KEY, DRILL ROD
PIN, COTTER
NUT, CASTLE
HANDWHEEL, ASSEMBLY
SCREW, CAP
WASHER, LOCK
NUT, REGULAR
RA FSD 2013

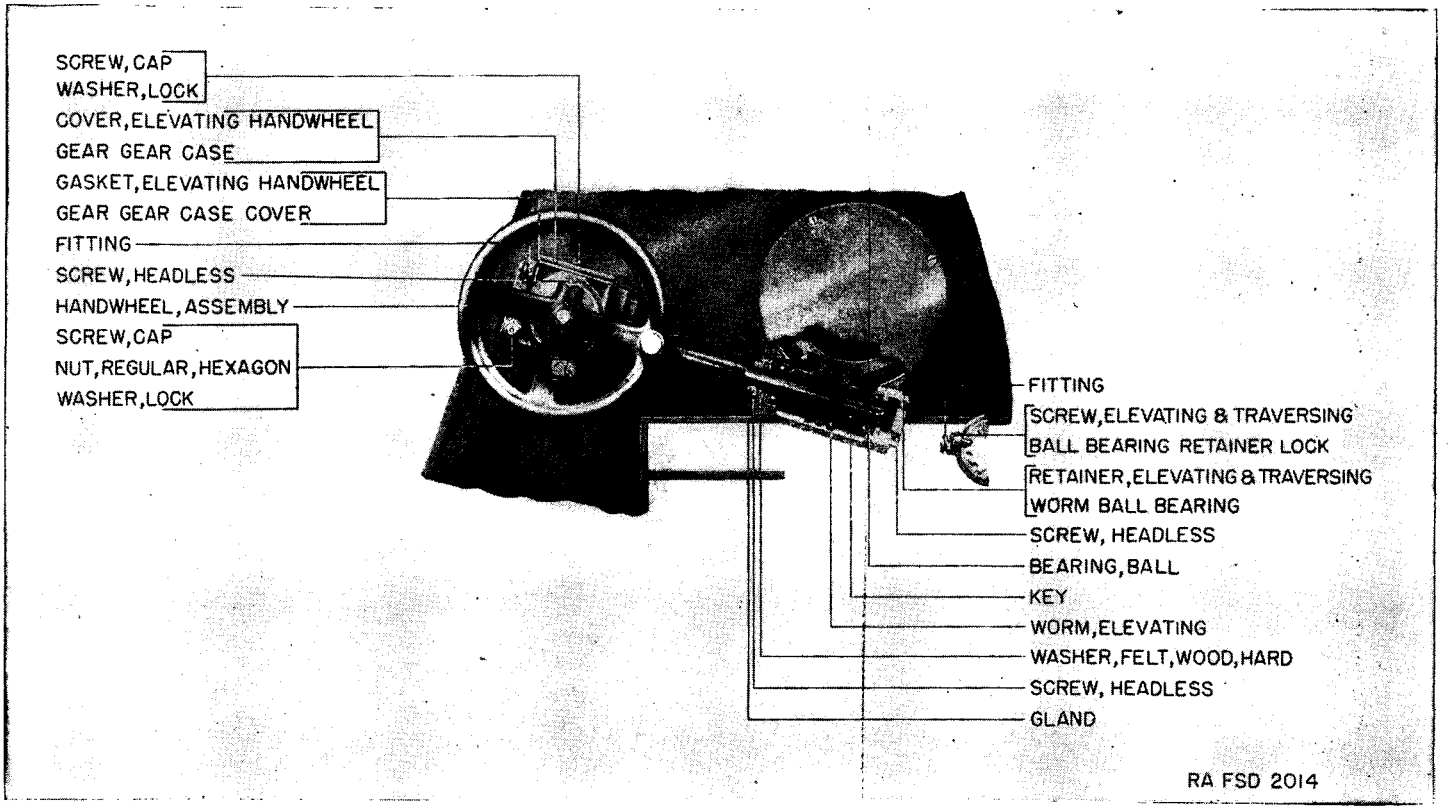


FIGURE 25.—Elevating mechanism M2A2.

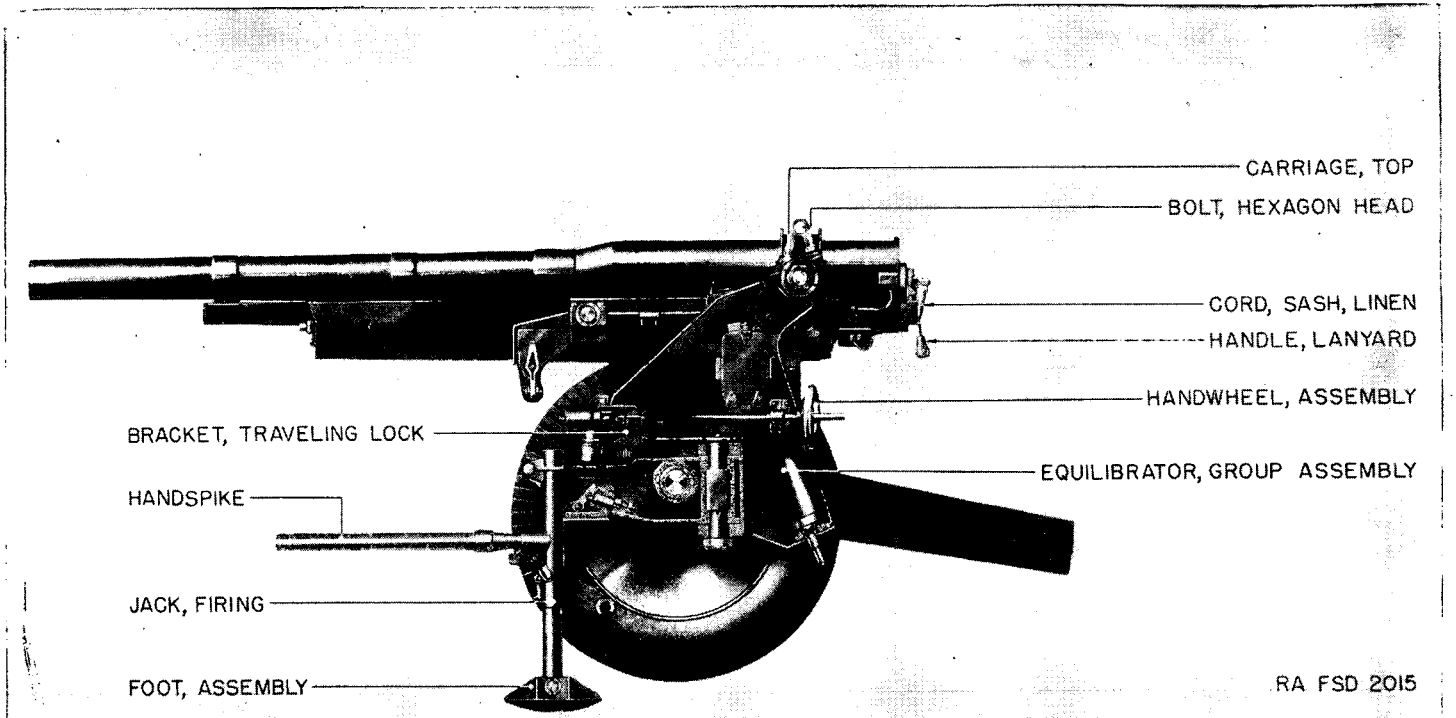


FIGURE 26.—75-mm gun carriage M2A2, left elevation.

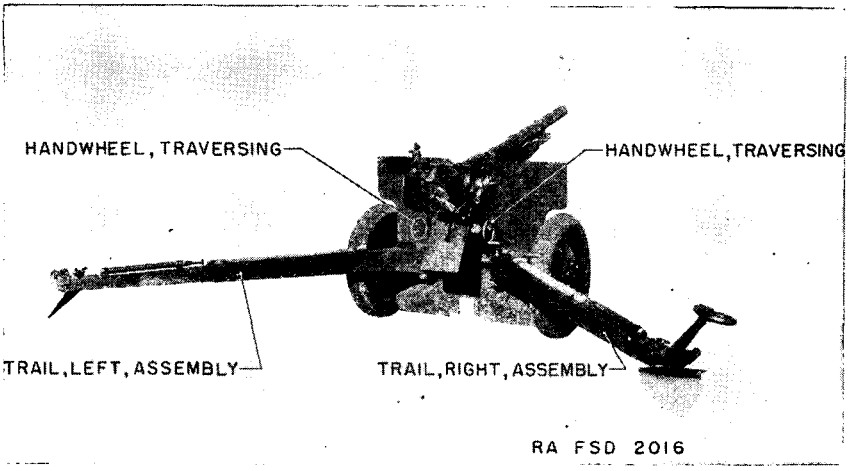


FIGURE 27. M2A2 carriage, firing position.

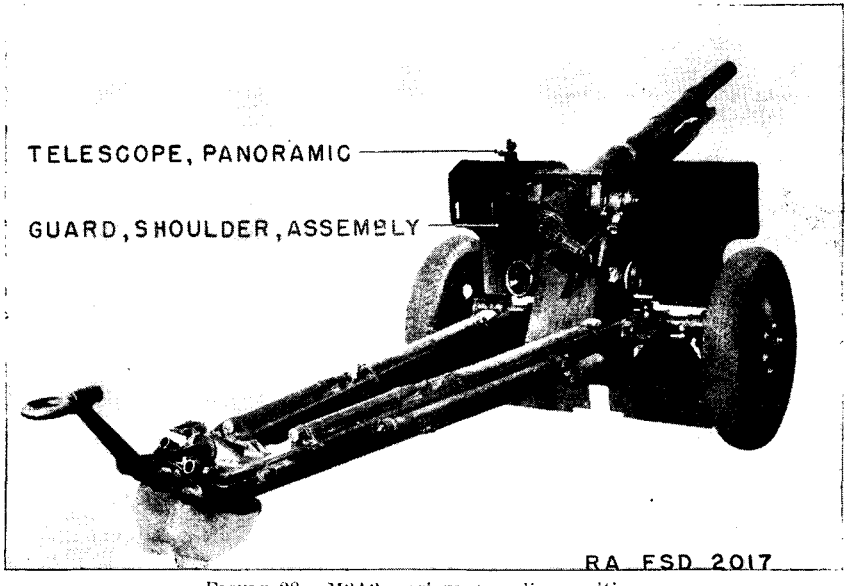


FIGURE 28.—M2A2 carriage, traveling position.

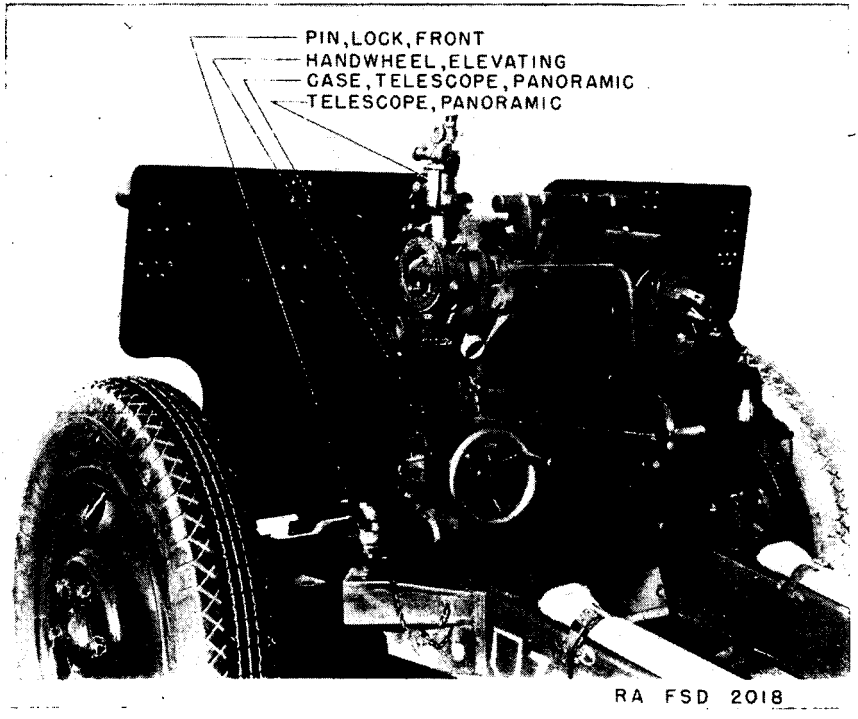


FIGURE 29.—M2A2 carriage, left side.

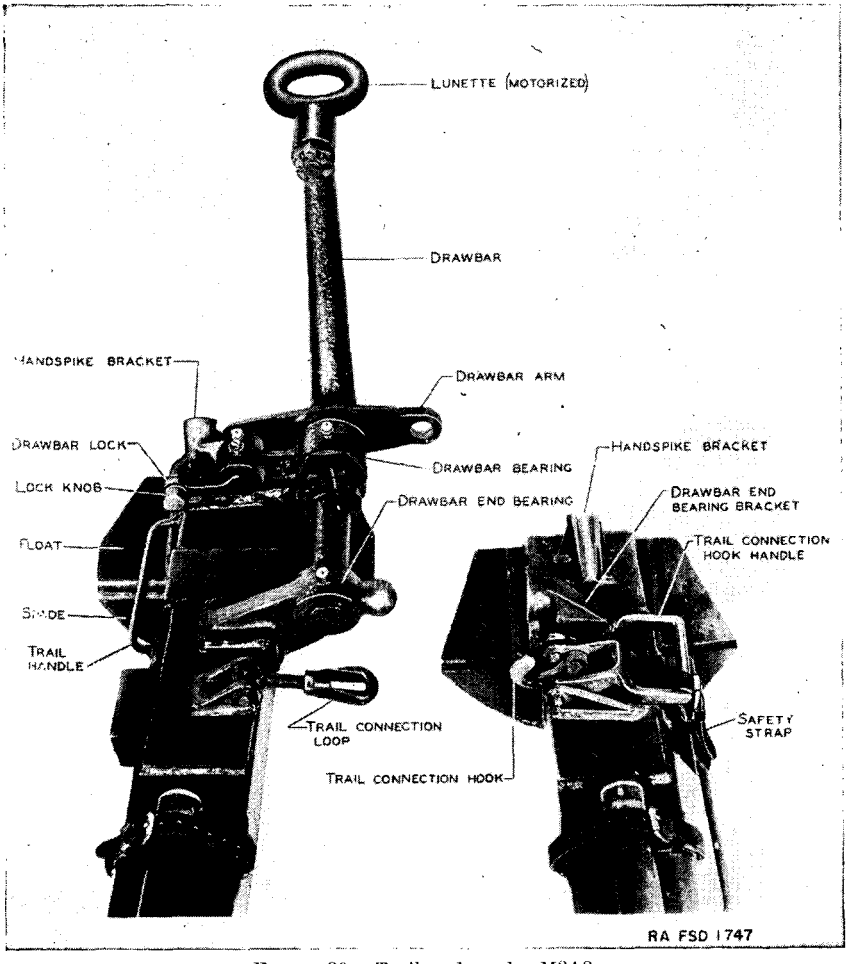


FIGURE 30.—Trail and spades M2A2.

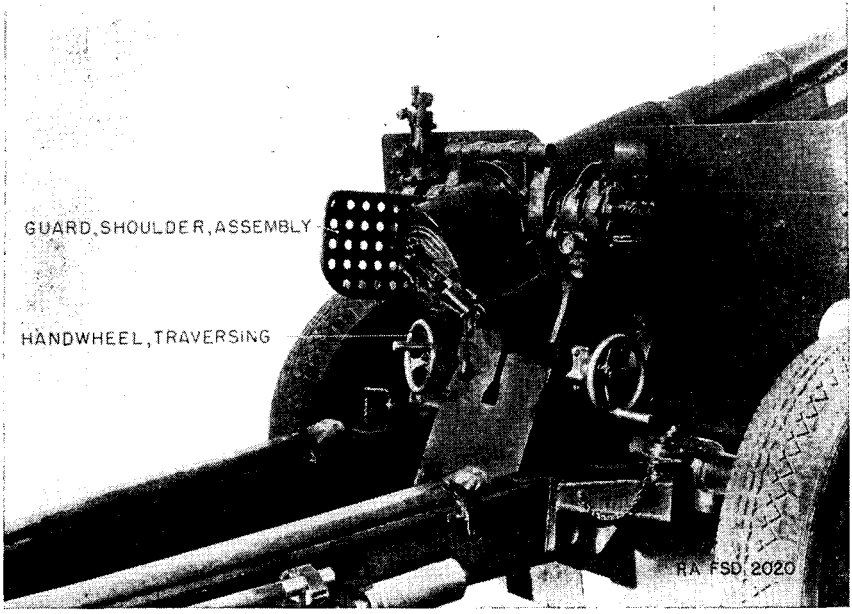


FIGURE 31.—M2A2 carriage, rear view.

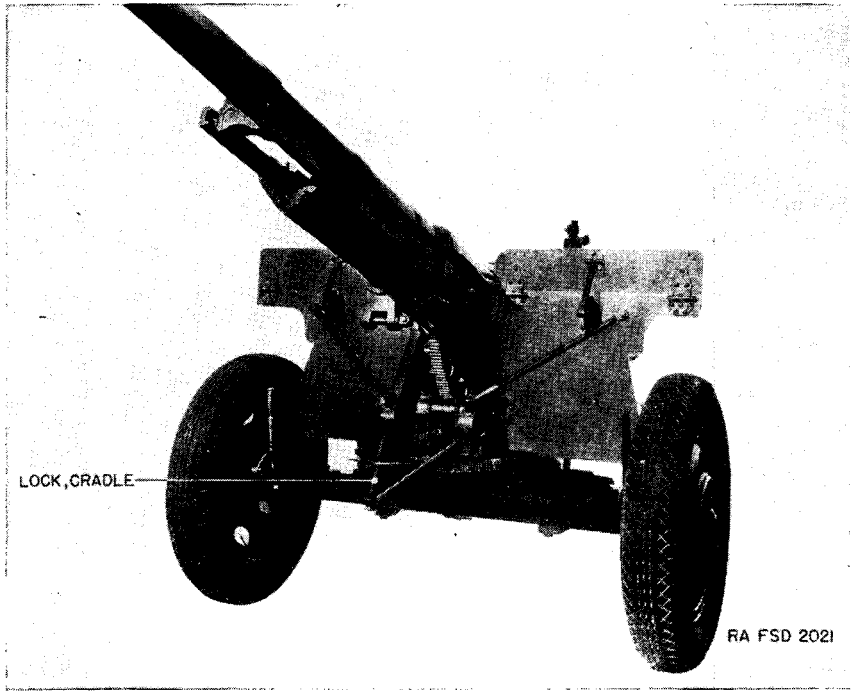


FIGURE 32.—75-mm gun carriage M2A3, front view.

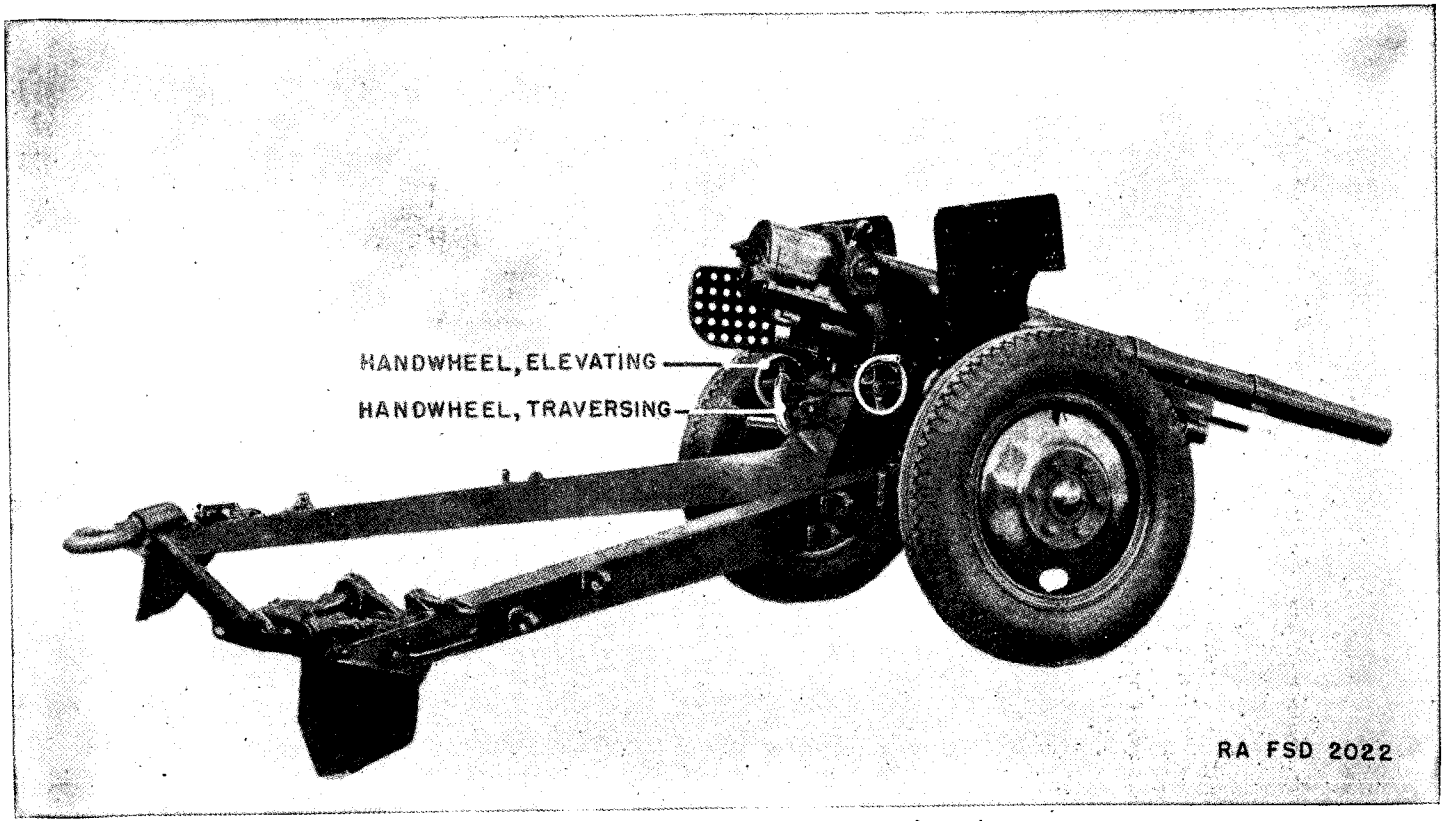


FIGURE 33.—75-mm gun carriage M2A3, maximum depression.

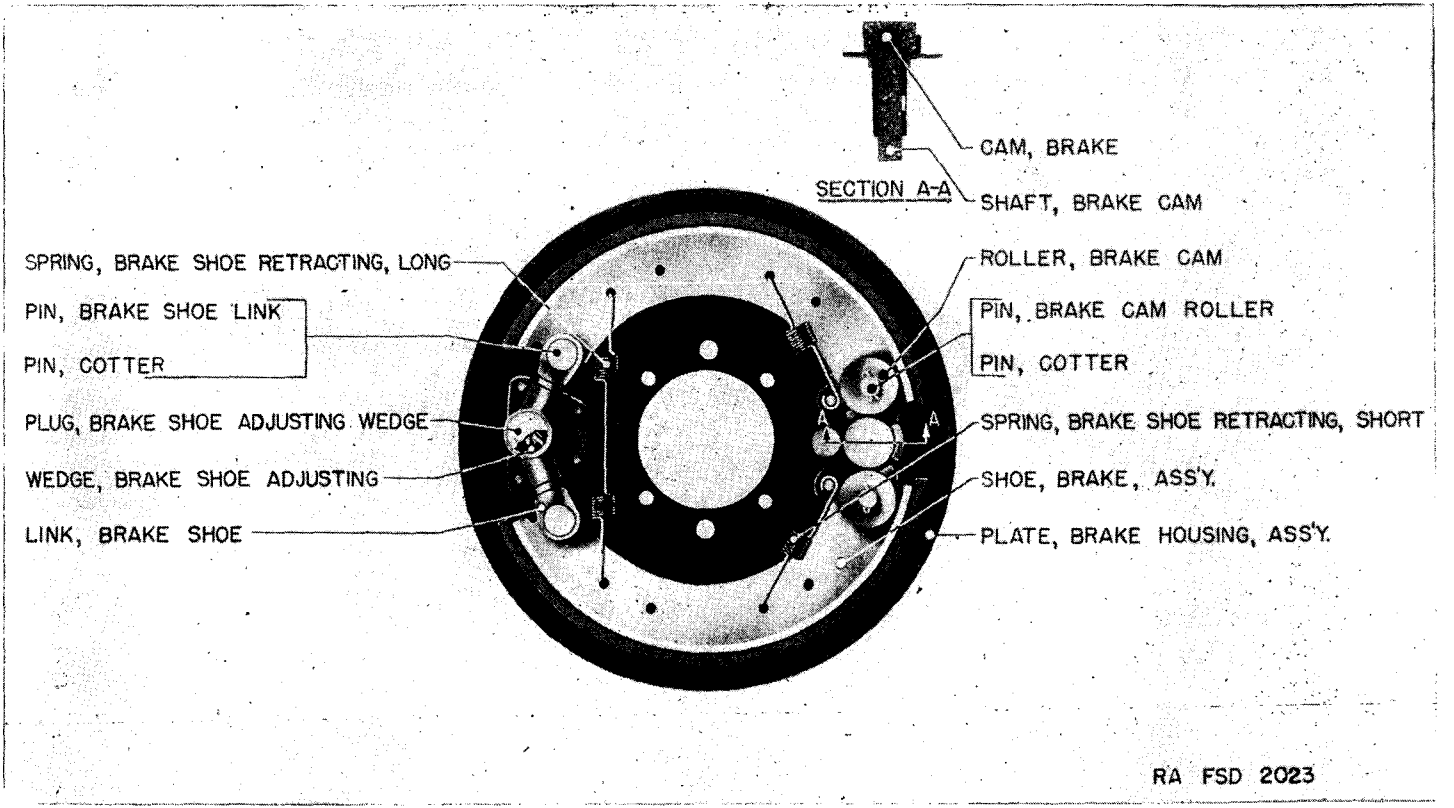


FIGURE 34.—Brake mechanism.

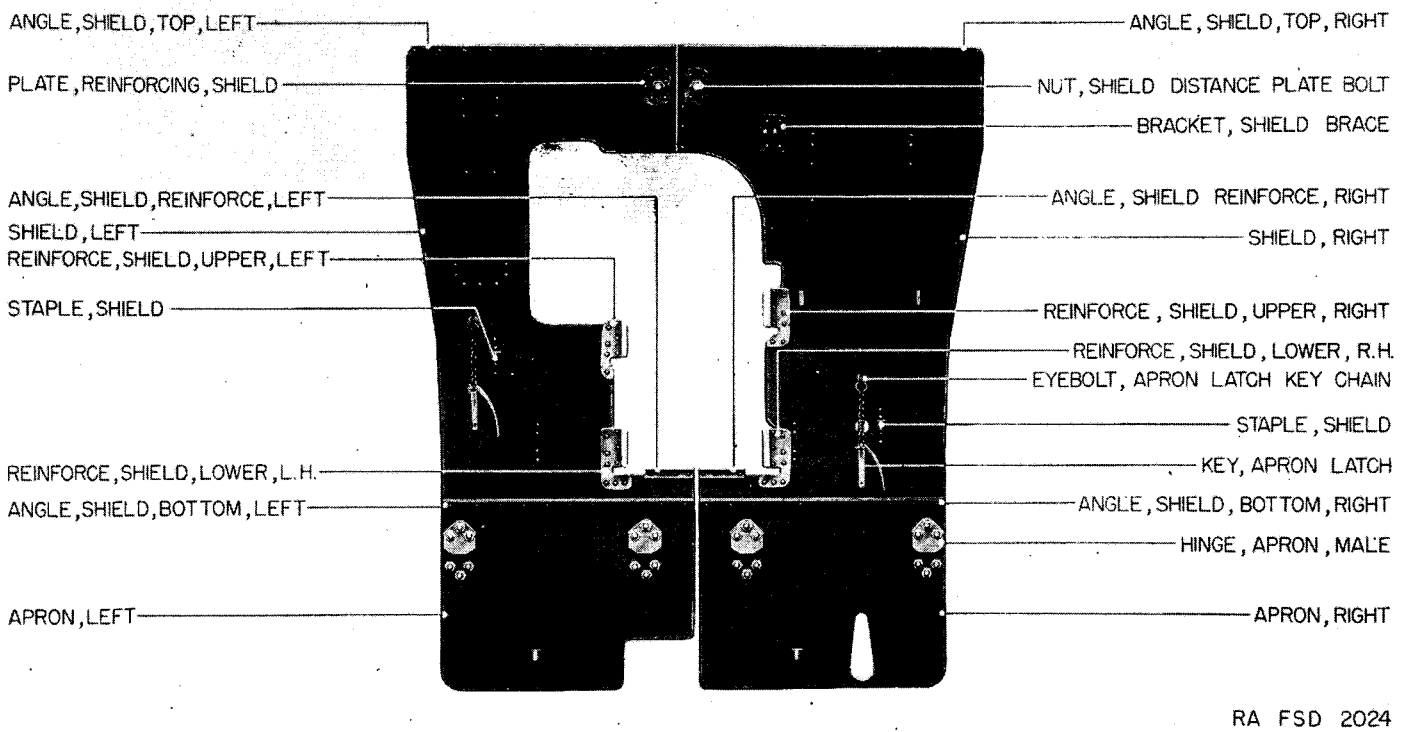


FIGURE 35.—American four-piece shield, rear view.

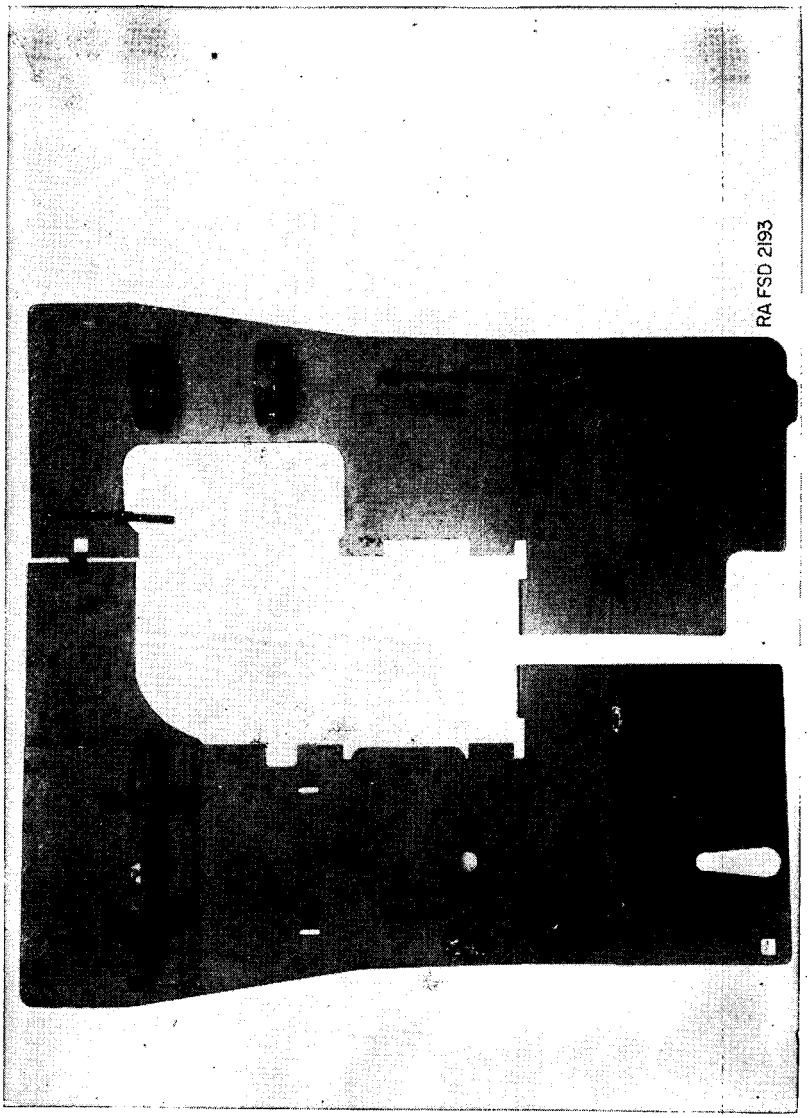


FIGURE 36.—French seven-piece shield, front view.

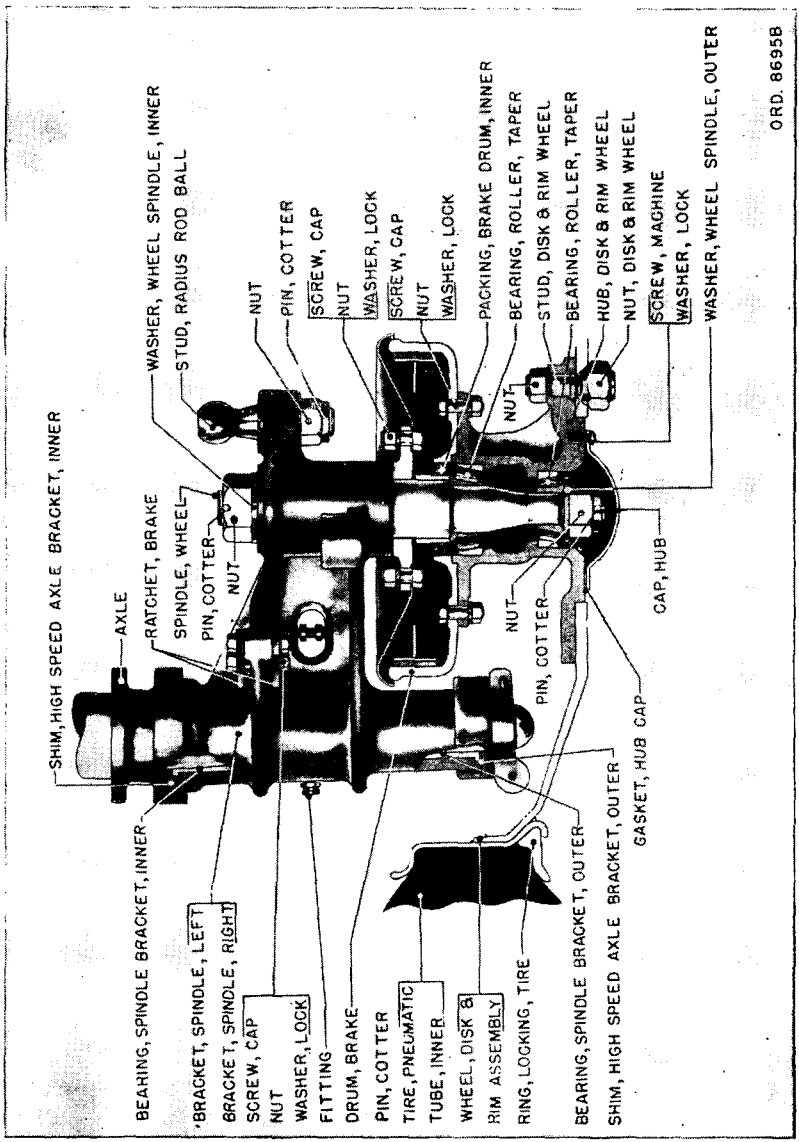


FIGURE 37.—Brake and axle bracket assembly.

CHAPTER 3

SIGHTING AND FIRE-CONTROL EQUIPMENT

Paragraphs
Section I. Sighting equipment 43–52
II. Fire-control equipment 54–60

SECTION I

SIGHTING EQUIPMENT

Paragraph
Light, aiming post, M14 43
Mount, telescope, M15, and panoramic telescope M5 or M5A2 44
Mounts, telescope, M15A1 and M22, and panoramic telescopes M5A4 and M12A1 45
Mount, telescope, M23, and elbow telescope M14 46
Light, instrument, M5 47
Post, aiming, M1 48
Quadrant, gunner's 49
Quadrant, range 50
Sight bore 51
Sight M1901 (French) 52
Target, testing 53

43. Light, aiming post, M14.—The aiming post light M14 is a device for illuminating ranging poles for night survey. It is a replacement for aiming lanterns M1 and M2.

a. The light (figs. 38 and 39) consists of a battery case for two BA–30 batteries (one in each end to obtain a parallel circuit), with a lamp housing and a toggle switch. A metal hood for the lamp is provided which is carried around the battery case when not in use. Illumination is furnished by a 3-volt aircraft instrument panel lamp with which standard instrument lights are now equipped. A reflector is mounted in the back of the lamp and a color filter can be attached to the front of the lamp housing.

b. A clamp is provided to secure the lamp to the aiming post.

c. A chest is provided to carry a section set comprising two lights, aiming post (one with red, one with green filters); eight BA–30 batteries; and two spare lamps.

d. The batteries should always be removed from the battery case when not in use in order that their deterioration on long standing will not damage the light. When not in use, the various parts of the light should be kept in the chest provided.

44. Mount, telescope, M15, and panoramic telescope M5 or M5A2.—This telescope and mount (fig. 40) furnished with each 75-mm gun and carriage M2A1 or M2A2 form the sighting element for aiming the gun. The mount is of the azimuth compensating type, automatically applying the necessary azimuth correction for cant. It is mounted on the left side of the carriage. Telescope and mount are being equipped with instrument light M7.

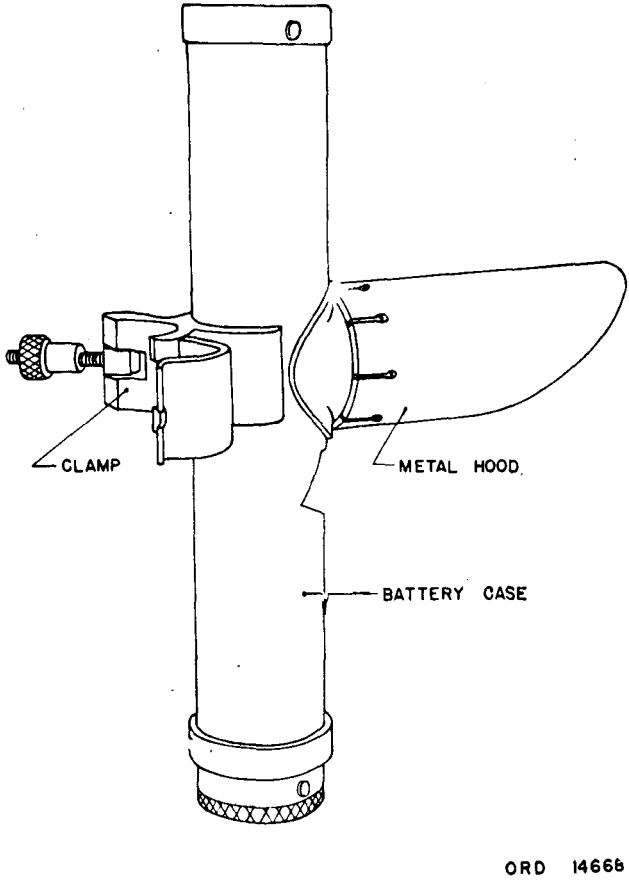


FIGURE 38.—Aiming post light, M14.

a. Description of mount.—The body of the mount, which supports the telescope socket, is positioned in part by a central pivot which is permanently alined to the bore of the gun. The body is also positioned longitudinally and in cross level by knobs operating worm drives. Two levels are provided. The cross level when centered

indicates the normal line of sight of the telescope to lie in a vertical plane parallel to the bore of the gun, while the longitudinal level when centered indicates the telescope to be vertical and hence deflections (azimuths) indicated on the scale are then measured in a truly horizontal plane. For traveling, a locking device is provided which holds the mount in the position shown in figure 41.

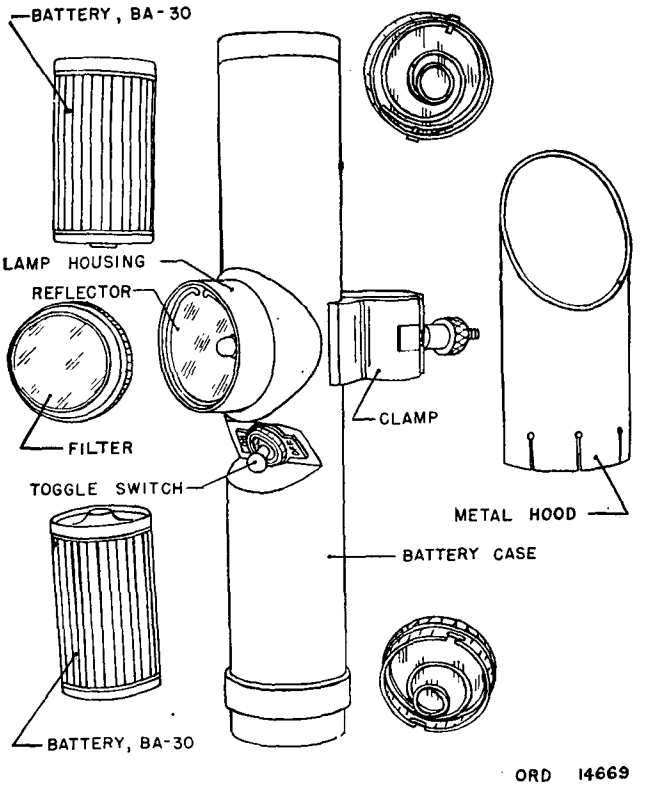


FIGURE 39.—Aiming post light M14 disassembled.

b. Description of telescope.—The panoramic telescope M5 or M5A2 is a 4-power telescope with a rotating head and azimuth mechanism by which the line of sight may be directed to any desired azimuth, and with a movable prism permitting the line of sight to be elevated or depressed through a limited angle as required to keep the aiming point within the field of view. The image viewed by the observer is erect. Both objective and eyepiece are the fixed focus type designed for normal eyesight and for ranges ordinarily encountered. The reticle contains a vertical and a horizontal cross line, the latter being

marked at 5-mil intervals and numbered at the 50-mil point on each side. The line of sight is elevated or depressed by means of the knob at the top, and coarse and fine index graduations are provided for the normal (zero elevation) position, but there are no means for reading

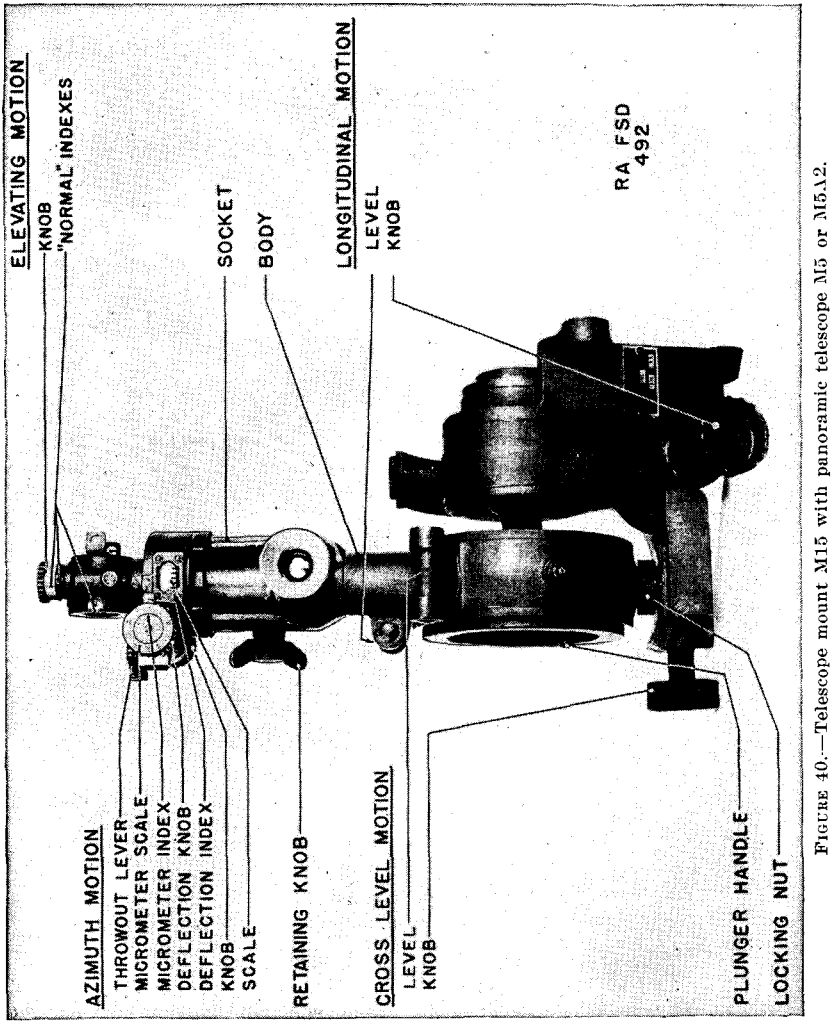


FIGURE 40.—Telescope mount M15 with panoramic telescope M5 or M5A2.

other angles of elevation. The azimuth scale is graduated at 100-mil intervals, numbered progressively 0 to 32 in two consecutive semicircles; zero readings indicate line of sight to be directly forward as in figure 40 or directly backward. The telescope is moved in azimuth by means of the associated knob which has a throw-out lever to

permit disengagement for rapid motion when required. Indications by the azimuth micrometer index opposite the white graduations of the associated scale, which is graduated at 1-mil intervals, supplement those on the azimuth scale. The micrometer scale also indicates deflections, white graduations for deflections to the left and red graduations for deflections to the right. The micrometer scale is arranged to be offset for insertion of corrections by means of the deflection knob. A detent on this motion gives a distinct click for each 1-mil movement and the total correction is indicated by the

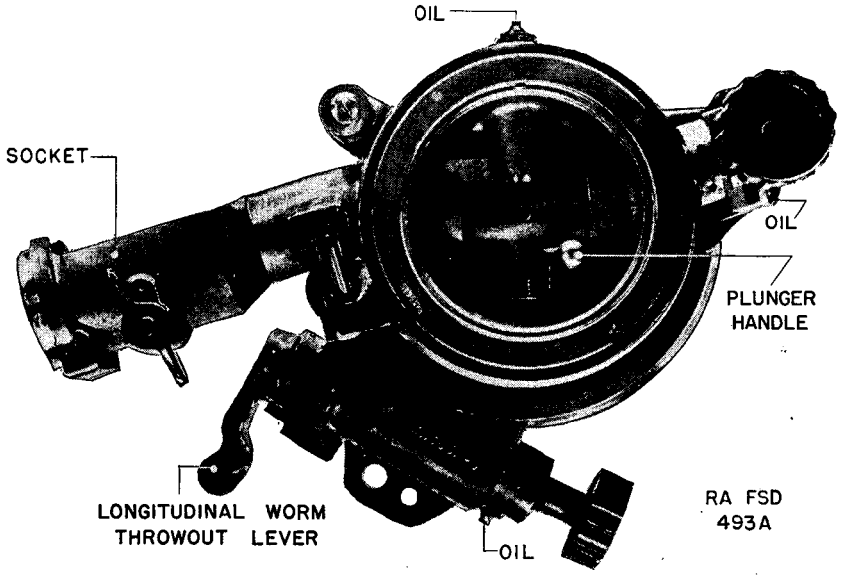


FIGURE 41.—Telescope mount M15, traveling position.

fixed deflection index. The telescope, which fits in cylindrical locating surfaces of the support, has a projecting lug to locate it correctly in azimuth. It is removable for traveling.

c. Operation.—(1) *Preparation.*—To place the mount and telescope in operation (fig. 41) remove the cover, grasp the socket in one hand, and with the other push the plunger handle down, then to the left, and release. Swing the socket to an approximately vertical position and with the free hand push the longitudinal worm throw-out lever clockwise until it snaps in place. Release the socket. Remove telescope from case. Turn the retaining knob to its extreme counterclockwise position and place telescope gently in the socket. Exert slight pressure downward to insure that both top and bottom alining surfaces are firmly engaged. Uncover both levels.

(2) *Procedure.*—Operating procedure depends upon whether direct or indirect laying is to be employed, instructions for which are given separately. The procedure given is for uncorrected fire. Corrections ((5) below) are equally applicable to either kind of laying.

(3) *Direct laying.*—(*a*) Set telescope in elevation to normal and leave in this position as long as direct laying is used. Set micrometer scale to indicate zero deflection, opposite the fixed outer index.

(*b*) Set the lateral deflection to the desired value, using the combined indications on the azimuth scale (100-mil steps) and on the azimuth micrometer scale (1-mil steps). Deflections to left (trajectory displaced to left of line of sight) are indicated by the letter "L" and black scale designations. Deflections to right (trajectory displaced to right of line of sight) are indicated by the letter "R" and red scale designations. The azimuth scale has white numbering for left deflections only. For right deflections, subtract the value of the deflection from 3,200, or count the graduations backward from the zero of the azimuth scale. The azimuth worm may be disengaged for making large changes in deflection rapidly by depressing the throw-out lever.

(*c*) Operate the cross leveling knob of telescope mount so that bubble of the cross lever is continuously centered with respect to the graduations on the vial as long as firing is continued. Operate the longitudinal knob of telescope mount so that the horizontal cross line of the telescope reticle remains continuously on the target. Disregard the position of the longitudinal level.

(*d*) Operate traversing handwheel on the gun carriage so that the vertical cross line of telescope reticle remains continuously on the target. The piece is then properly laid in direction for direct laying.

(4) *Indirect laying.*—(*a*) Set azimuth micrometer scale to indicate zero deflection opposite the fixed outer index.

(*b*) Set firing angle to desired value, using the combined indications on the azimuth scale (100-mil steps) and on the azimuth micrometer scale (1-mil steps). Disregard red markings on the scale. Firing angle is the horizontal clockwise angle, apex of which is at the piece, measured *from target to aiming point.* For values up to 3,200 mils it is numerically equal to the value indicated on the azimuth scale of the telescope, the rotating head being directed to right of line of fire. For values of firing angle greater than 3,200 mils, subtract 3,200 from the value of the angle and make the setting with the rotating head directed to left of line of fire. The azimuth worm may be disengaged for making large changes in azimuth by depressing the throw-out lever.

(*c*) Operate the longitudinal and cross leveling knobs of telescope mount so that the bubbles of both levels are continuously centered with respect to the graduations on vials as long as firing is continued.

(*d*) Operate the traversing handwheel on the gun carriage so that the vertical cross line of the telescope reticle remains continuously on aiming point. The telescope may be elevated or depressed by the knob at the top as required to bring aiming point within field of view. It is not necessary to bring aiming point exactly on horizontal cross line. The piece is then properly pointed in direction for indirect laying.

(5) *Corrections.*—Corrections to firing angles or deflections may be introduced by using either of the two methods described below.

(*a*) *First alternative method.*—The micrometer scale is not offset but remains as originally set to indicate zero opposite the outer index. Corrections are introduced in the same manner as in making original azimuth or deflection settings by turning the azimuth micrometer index in the proper direction through the required number of 1-mil divisions.

(*b*) *Second alternative method.*—Each time the azimuth or deflector is set or changed, the micrometer scale is immediately rotated so that the azimuth micrometer index indicates zero. Corrections are introduced in the same manner as in making original azimuth or deflection settings, referred to zero on the scale in its new position. Before making such a setting, the indication should be checked to insure that a true zero indication is used as the starting point.

(6) *To place in travel position.*—When placing mount in traveling position, hold telescope to prevent its falling out through the open portion at rear of socket. Turn retaining knob counterclockwise which will lift and disengage the telescope. Remove telescope and place in case. Push plunger handle down and to the right and release. Operate the cross leveling mechanism of mount until the plunger is heard to snap up against the inner surface of the body. Grasp socket with one hand and with the other push the longitudinal worm throw-out lever counterclockwise until it snaps into its disengaged position. Lower socket downward and forward slowly until plunger snaps into place, locking the mount in its traveling position. The hole into which the plunger snaps is located in line with the oil fitting on the body, which may be used to indicate approximate alinement. A small amount of motion in cross level may also be necessary to permit the plunger to snap into place freely. Protect both levels by closing their covers.

(7) *Night.*—For operation in darkness a window, exposed by turning the shutter located a short distance ahead of the eyepiece, permits illumination of the cross lines of the reticle, using an external light source (not included with the instrument). The shutter may be employed to regulate the amount of illumination.

d. Test and adjustment.—At conclusion of adjustment see that all screws and other parts loosened are made secure. No adjustment of the panoramic telescope other than authorized below is permitted.

(1) *Vertical bearing.*—Any play which may develop between the vertical stud on the cross leveling worm gear segment and the split bushing in the body must be removed by adjusting the locking nut sufficiently to remove the clearance. The locking nut has a set screw which must be loosened before adjusting and tightened when adjustment is completed.

(2) *Level.*—Level telescope mount by means of a test level placed on the flat machined surface of the telescope socket. Place level alternately longitudinally and traversely and operate the associated controls of the mount until a level indication is obtained simultaneously in both directions. The cross level bubble should then be centered within one division and the longitudinal level bubble should be centered within three divisions. No adjustment by the using arm is permitted. Levels are properly adjusted at the time instruments are assembled and it is seldom that future adjustment is necessary.

(3) *Bore sighting.*—Level piece transversely and longitudinally. Place bore sights in position and testing target vertically at a distance of about 50 yards so that axis of the bore passes through the point on the target so marked. Place telescope mount in operation for indirect fire, setting elevation at normal and firing angle and correction at zero. Line of sight and axis of the bore should then be parallel, and aiming point on the target should appear exactly at the intersection of the cross lines on the reticle. If this is not the case further adjustment must be made as follows:

(*a*) If horizontal line on reticle is not in agreement with corresponding line on testing target, turn telescope elevating knob until these lines are in agreement. Then loosen locking screw in end of knob and slip knob around until the indexes are in agreement. Do not lift the knob during this adjustment as the stop rings within the knob may become disarranged. Tighten the locking screw, taking care not to disturb the adjustment. Should the coarse indexes then fail to be matched, a serious maladjustment is indicated and the telescope should be turned in for repair.

(*b*) If vertical line on reticle is not in agreement with corresponding line on testing target, turn azimuth knob until lines are in agreement. Loosen deflection index locking screw and rotate index to zero indication, using the teat wrench. Tighten locking screw but do not disturb the adjustment. Should the azimuth scale then fail to indicate zero, a serious maladjustment of telescope or mount is indicated and the entire instrument should be turned in for repair.

(4) *Alinement of pivot.*—Alinement of axis of actuating arm pivot to be parallel with axis of bore of gun may be partially checked by elevating the gun, complying otherwise with conditions given for bore sighting. Failure of vertical cross line to remain on aiming mark indicates lack of alinement, necessitating turning in of the instrument.

e. Care and preservation.—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Avoid striking or bumping any part of the instrument, and particularly denting or burring of locating surfaces of mount and telescope.

(3) When not in use, keep the telescope in its case and the level vials covered.

(4) Stops are provided on the longitudinal and cross leveling motions of mount and on the elevating motion of telescope. Do not attempt to force rotation of any of the knobs beyond these limits.

(5) Be sure longitudinal worm is disengaged and plunger free to snap into the hole provided for it before attempting to place mount in traveling position and make sure that the throw-out lever is returned to its extreme clockwise position when mount is placed in operating position. For travel, plunger handle should be kept in its upper position and worm throw-out lever should be kept in its lower position.

(6) Oil the principal bearing surfaces occasionally, using oil, lubricating, for aircraft instruments and machine guns. Three oil fittings are provided for this purpose (fig. 41). Also keep telescope retaining shaft and other parts well oiled. Keep locating surfaces of telescope, telescope socket, and retaining shaft lightly coated with grease, special, low temperature. Wipe off lubricant seeping from the moving parts to prevent accumulation of dust and grit. Exercise particular care to keep optical parts free from oil and grease.

45. Mounts, telescope, M15A1 and M22, and panoramic telescopes M5A4 and M12A1.—*a.* Panoramic telescope M12A1 is now standard for carriages M2A1, M2A2, and M2A3, but panoramic telescope M5A4, made by converting existing components, will be manufactured until the former can be issued. Steps are being

taken to replace all panoramic telescopes of the M5A2 type on 75-mm gun carriages M2A1 and M2A2 with the M5A4 instruments. These panoramic telescopes differ from the M5A2 type in the following respects:

(1) Eyepiece axis is offset 45° from bore axis.

(2) Reticle, in addition to vertical and horizontal cross lines, has—

(*a*) Angular graduations to right and left at 5-mil intervals numbered every 10 mils up to 40 mils.

(*b*) Range graduations at angles corresponding to elevation for zero (optical center), 400, 800, 1,200, and 1,600 yards when firing 75-mm HE shell, Mk. I with normal charge at 1,784 foot-seconds.

b. Telescope mount M15A1 is a modification of telescope mount M15 to accommodate the 45° offset of the eyepiece axis of the panoramic telescope.

c. Telescope mount M22 is used on the 75-mm gun carriage M2A3. It is designed to permit direct laying both in direction and elevation, by a single operator when required. Ordinarily it will be used for laying in direction only, as it has been found that speed and accuracy of fire are improved when the duties of laying are divided between two operators. In the two-man system, range quadrant M5 is used to lay indirectly for elevation and elbow telescope M14 and telescope mount M23 are mounted on the range quadrant to lay directly for elevation.

46. Mount, telescope M23, and elbow telescope M14.—*a. Description.*—(1) *Elbow telescope.*—The elbow telescope M14 is standard for gun carriages M2A1, M2A2, and M2A3. It is used for direct fire on moving targets. The telescope is a 3-power fixed focus telescope provided with range graduations on the reticle. The reticle is provided with range lines only, with the normal line passing through the optical axis of the instrument. The lines represent elevations for ranges from zero to 1,600 yards in 200-yard steps. The normal line of sight, marked "N" on the reticle, is designed to be alined parallel to the bore of the piece. The telescope mount M23 is used with elbow telescope M14.

(2) *Telescope mount.*—The telescope mount M23 is fastened to the extension on the upper portion of range quadrant M5. The knob on the upper portion of the telescope mount rotates the telescope for setting the reticle lines to the horizontal position. This setting must be done by observation, as there is no mechanical means for determining the setting. An adjusting motion, consisting of a worm with screw driver slot and a clamping bolt, is provided for alining the elbow telescope in elevation.

b. Operation.—(1) Clamp the elbow telescope in the bracket of the telescope mount, having first wiped all dust and grit from the bearing surfaces. Be certain that the telescope is fully inserted, that the projecting lug fits the mating opening in the telescope mount, and that the wing nut is securely tightened. Set the telescope reticle lines horizontal by means of the knob at the top of the telescope mount.

(2) Elevate or depress the gun until the target appears on the reticle graduation corresponding to the target range.

c. Care and preservation.—(1) Refer to paragraph 60 for general instructions pertaining to the care and preservation of instruments.

(2) Place the elbow telescope in its carrying case when not in use. In doing so always slide the adapter and eyeshield along the telescope tube until the end of the eyeshield is flush with the end of the tube to prevent flattening the shield.

(3) Stops are provided to limit the longitudinal and cross leveling motions and no attempt should be made to force the mechanisms beyond these limits. Avoid rough handling which might disturb the adjustments.

(4) The level vials are fitted with covers which should be turned to protect the level vials when the equipment is not in use.

47. Light, instrument, M5.—This instrument light is used with panoramic telescopes M5A4 and M12A1, and telescope mounts M15A1 and M22 to illuminate the reticle, azimuth scale, azimuth micrometer, and indexes on the telescope, and the cross level and longitudinal level on the mount (fig. 42).

a. Description of parts.—(1) The main body (fig. 43) of the instrument is held firmly against the telescope socket by two clamps in such a position that the horizontal leg of the telescope fits into the semicircular notch in the lamp housing.

(2) Two flashlight cells (Signal Corps BA–30) in series, from which power is drawn for the 3-volt special aircraft type lamp, are contained in the battery tube. The average life of the cells is 7 to 8 hours' continuous service, and that of the lamp 400 hours. A switch is built into the bottom cover of the tube.

(3) The two light-transmission tubes contain rods of a clear plastic which possesses the characteristic of being able to transmit light along its length with slight loss, provided that the rods are uniform in cross section and highly polished.

b. Illumination system.—(1) The reticle of the telescope is illuminated directly by the lamp through a window in the horizontal leg

of the telescope. A shutter covers the window when the light is not in use.

(2) Light transmitted through the larger tube illuminates the azimuth micrometer on the telescope. A part of the tube is cut

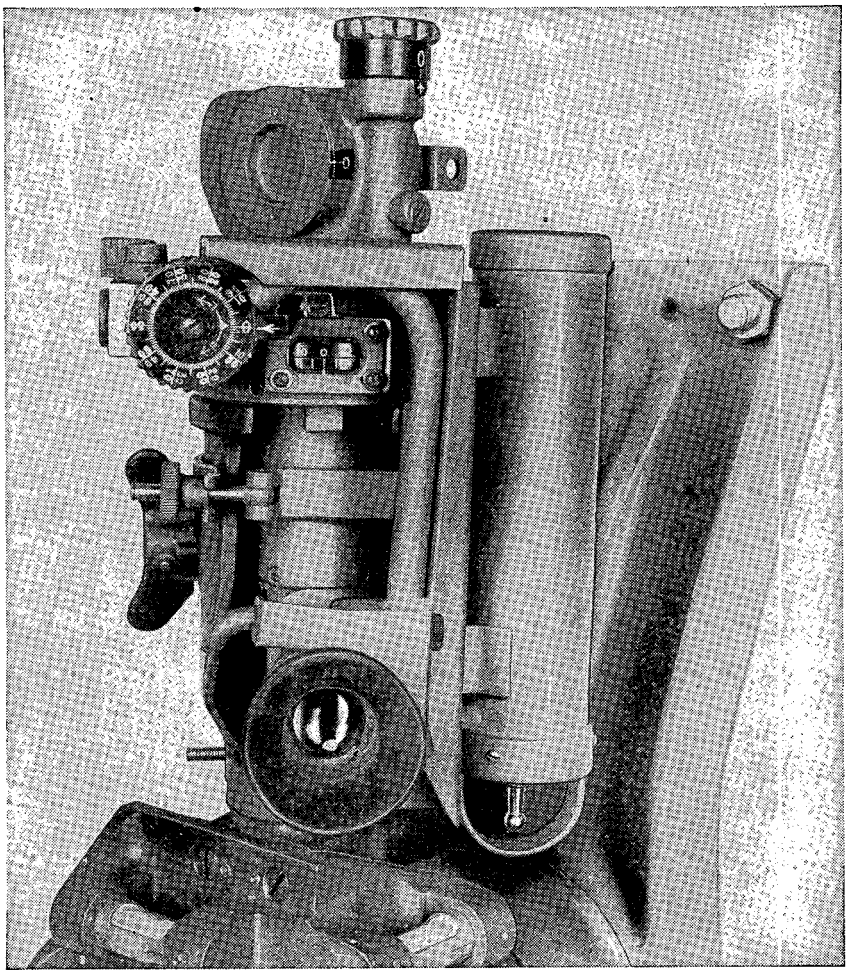


FIGURE 42.—Instrument light M5, mounted.

away near its upper end, exposing the plastic rod (fig. 43). The rod is lightly sand-blasted at that point, causing light to be diffused on the azimuth scale of the telescope.

(3) The longitudinal level on the mount is illuminated by light transmitted through the smaller tube from the lamp in the lamp

housing. The cross level is illuminated directly by the lamp through a hole in the bottom of the lamp housing.

48. Post, aiming, M1.—This aiming post (fig. 44) consists of two tubular sections each approximately 4 feet long. The lower

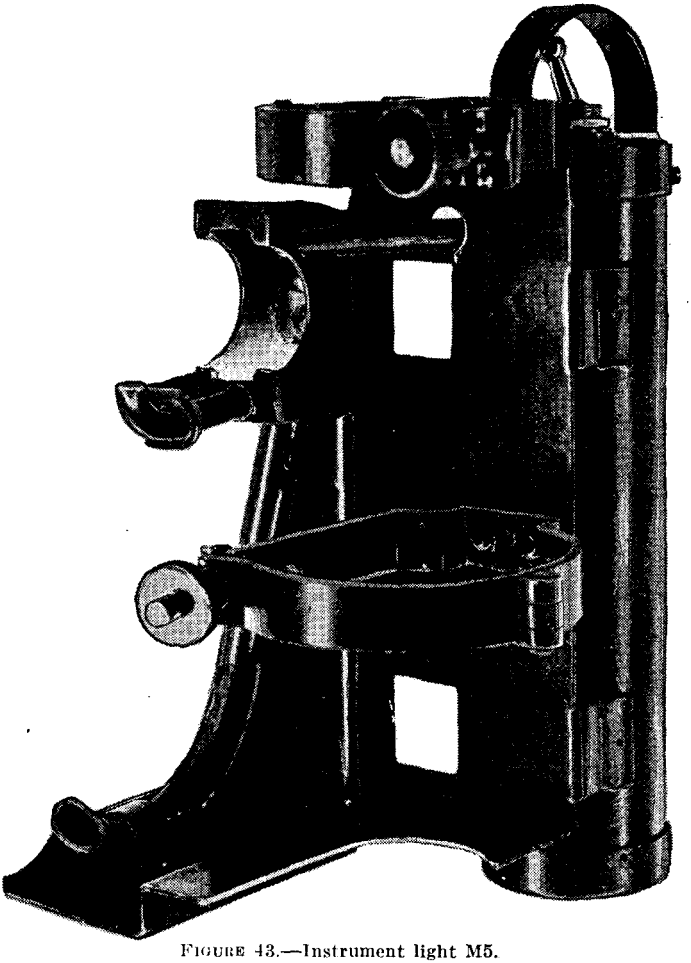


FIGURE 43.—Instrument light M5.

section has a metal point for embedding in the ground and the upper section is provided with a joint and catch fitting in the upper end of the lower section. The parts are painted with alternate 4-inch red and white bands. A canvas cover holding both sections is provided. If it is necessary to drive the lower section into the ground, interpose a wood block or use other means to insure that the surface mating with the upper part is not injured.

49. Quadrant, gunner's.—Each gunner's quadrant is furnished complete with packing chest.

a. M1918.—(1) *Description.*—This quadrant (fig. 45) includes a sector-shaped frame to which is pivoted an arm carrying a level.

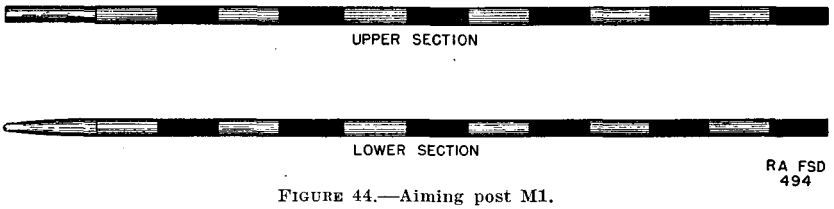


FIGURE 44.—Aiming post M1.

Notches on the frame engaging with a plunger in the arm permit rapid setting of the arm in 10-mil steps to the desired angle as indicated on the coarse scale. The arm is slightly curved and the level guide is arranged to be positioned along the arm to provide a fine

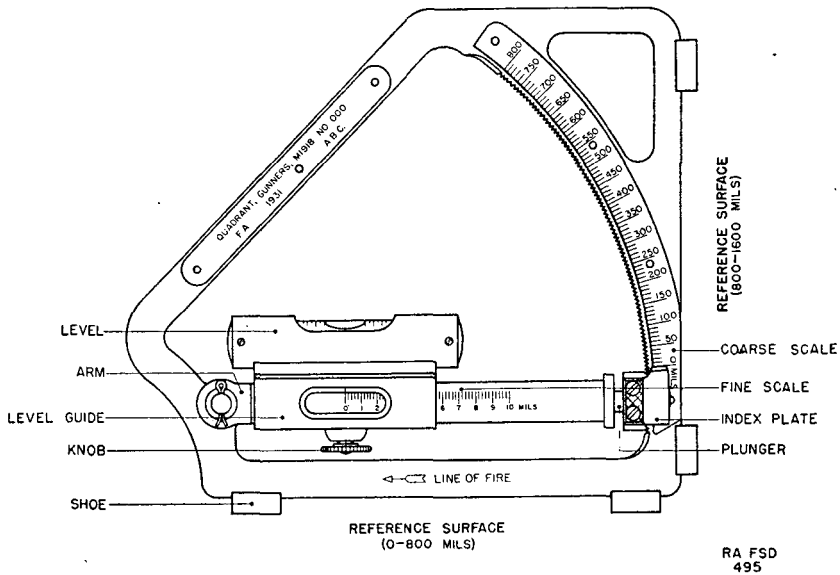


FIGURE 45.—Gunner's quadrant M1918.

indication supplementing that on the coarse scale. The frame has two reference surfaces, one used for elevations from 0 to 800 mils and the other from 800 to 1,600 mils. Separate indications on opposite sides of the quadrant are used for the two different regions.

(2) *Operation.*—(*a*) To measure elevation of the piece, place proper reference surface of the quadrant on leveling plates parallel to

the bore with the associated arrow pointing in the direction of fire. Clamp level guide to indicate zero on the fine scale. Disengage plunger from notches in frame, lift arm, and slowly lower it until bubble is seen to pass through the central point. Allow plunger to engage with notches and slide level guide along the arm until level bubble is accurately centered. Face side of quadrant which bears the arrow in use and read the coarse and fine scales. Elevation of the piece in mils is equal to the sum of the coarse and fine scale readings. Remove quadrant from piece before firing.

(*b*) To measure depression angles proceed as above, but with arrow pointed in reverse direction.

(*c*) To lay the piece to a given elevation, set scale and micrometer to required angle and place corresponding reference surface on leveling plates of piece. Elevate piece, then depress it until level bubble is centered. Remove quadrant from piece before firing.

(3) *Test and adjustment.*—(*a*) No adjustment of the quadrant by using arm is permitted.

(*b*) The zero indication may be verified by setting the quadrant to zero elevation, elevating or depressing piece to center the bubble, then turning quadrant end for end. If bubble is not centered, determine the elevation or depression angle necessary to center it; one-half of this angle is the error and a corresponding correction should be applied to all subsequent indications in the 0–800 mil region.

(*c*) To test accuracy of the arm, clamp level guide to indicate zero on the fine scale and set arm to any convenient multiple of ten on the coarse scale. Center bubble by elevating or depressing piece. Move arm down one notch and slide level guide to indicate 10 on the fine scale. Bubble should remain centered.

b. M1.—(1) *Description.*—This quadrant (fig. 46) includes a sector-shaped frame to which is pivoted an arm carrying a level. Notches on the frame engaging with a plunger in the arm permit rapid setting of the arm to desired angle. The frame has two reference surfaces, one used for elevations from 0 to 800 mils and the other from 800 to 1,600 mils. Separate scale and micrometer indications on opposite sides of the quadrant are used for the two different regions.

(2) *Operation.*—(*a*) To measure the elevation of the piece place proper reference surface of quadrant on leveling plates parallel to bore with the associated arrow pointing in the direction of fire. Set micrometer to zero. Disengage plunger from notches in the frame, lift arm and slowly lower it until bubble is seen to pass through the central point. Allow plunger to engage with notches and turn mi-

crometer until level bubble is accurately centered. Face side of quadrant which bears the arrow in use and read the scale and micrometer indications. A note engraved below the micrometer indicates whether red or black micrometer figures are to be read. A zero micrometer indication is read as 0 mil when the auxiliary indexes are matched (as in fig. 46) and as 10 mils when they are not matched. Elevation of the piece in mils is equal to the sum of the scale and micrometer readings. Remove quadrant from the piece before firing.

(*b*) To measure depression angles proceed as above, but with arrow pointed in reverse direction.

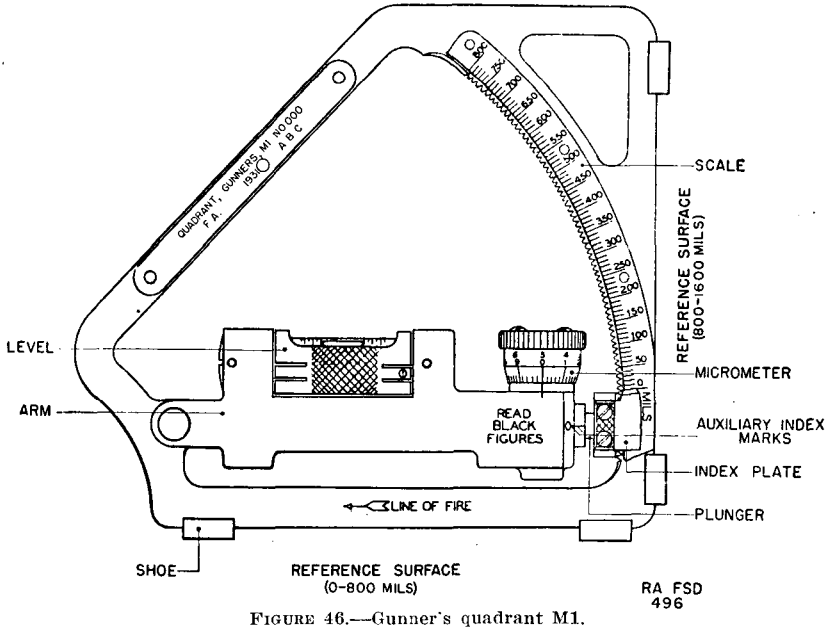


FIGURE 46.—Gunner's quadrant M1.

(*c*) To lay the piece to a given elevation, set scale and micrometer to the required angle and place the corresponding reference surface on leveling plates of piece. Elevate piece, then depress it until level bubble is centered. Remove quadrant from piece before firing.

(3) *Test and adjustment.*—No adjustment of quadrant by using arm is permitted. The zero indication may be verified by setting quadrant to zero elevation, elevating or depressing the piece to center the bubble, then turning quadrant end for end. If the bubble is not centered, determine elevation or depression angle necessary to center it. One-half of this angle is the error and a corresponding correction should be applied to all subsequent indications in the 0–800 mil region.

(4) *Care and preservation.*—(*a*) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(*b*) Exercise particular care to prevent burring, denting, or nicking of the reference surfaces and of the notched portion of the frame.

(*c*) Never leave quadrant on the piece when firing.

(*d*) When not in use keep quadrant in its chest with the shoes forming the reference surfaces lightly greased with petrolatum.

50. Quadrant, range.—*a. M1.*—This range quadrant (fig. 47) furnished with each 75-mm gun and carriage M2A1 or M2A2 is used for laying the gun in elevation. It is mounted on the right-hand side of the carriage in prolongation of the axis of cradle trunnions. Settings are made on the quadrant in accordance with data from external sources and the proper laying of the gun is then accomplished by matching a pair of indexes.

(1) *Description.*—(*a*) The quadrant includes a level and leveling mechanism for establishing a horizontal datum plane, angle of site, and angle of elevation mechanisms which introduce and add together their respective elements of data, a range drum whereby range settings may be made in lieu of angle of elevation settings, and a pair of indexes to indicate actual and computed gun positions.

(*b*) These range quadrants are being equipped with instrument light M6. This light includes a battery case on which is mounted a lamp housing with reflector and a finger light with flexible cord attached thereto.

(2) *Operation.*—(*a*) To operate the quadrant, any one of the three following combinations of data may be employed:

1. Angle of site in mils. Angle of elevation in mils.

2. Angle of site in mils. Range in yards (using only ammunition specified on range drum).

3. Quadrant elevation in mils (set as angle of elevation with angle of site set at normal (300 mils) since quadrant elevation already includes any necessary angle of site).

(*b*) Having made the necessary settings in accordance with the combination selected from the above listing, level quadrant by either of the leveling knobs, then elevate gun and depress it so that indexes are properly matched. Gun is then properly laid in elevation. Maintain the level in its central position and keep the indexes matched as long as firing is continued.

(*c*) Range drums for different projectiles may be interchanged by removing the three flat head screws in the end of the drum knob and withdrawing the knob and drum. Use care while disengaging

the pin of the pointer from the spiral slot in the drum. To replace the drum insert the pin of the pointer in the spiral slot and slide the drum into place. Bring the elevation scale and micrometer to zero and rotate the drum until the pointer indicates zero range simultaneously, then tighten the screws.

(*d*) To place in traveling position cover the level.

(3) *Test and adjustment.*—The various indexes all have slotted mounting holes to permit their alinement in the correct positions. Both micrometer and range drum are clamped in place by a nut or screws in their respective knobs, permitting adjustment to the proper indications. All required adjustments may be made by these means. Adjustment of level tube in its mounting is not permitted. To check and adjust instrument, proceed as follows:

(*a*) Set angle of elevation to zero. Scale and micrometer should indicate zero simultaneously. If they do not, shift micrometer or index or both to give required indication. With this setting zero range should also be indicated. If not, shift range drum to give required indication.

(*b*) Set angle of site to normal (300 mils). Scale and micrometer should indicate, respectively, 3 and 0 simultaneously. If they do not, shift micrometer or index or both to give the required indication. Place bore of gun in a horizontal position. Level the range quadrant. If the matching indexes are not then in alinement, adjust one or both until the proper indication is obtained.

(*c*) Should any index reach the limit of adjustment, one of the other indexes may be shifted in the proper direction to correct the difficulty, and the adjusting procedure repeated.

(*d*) Be sure adjusting nut and screws are securely tightened at completion of the adjusting operations.

(4) *Care and preservation.*—(*a*) Avoid striking or bumping any part of the instrument.

(*b*) Keep level vial covered at all times when not in use.

(*c*) Stops are provided to limit the motion of the revolving parts. Do not attempt to force the rotation of any of the knobs beyond these limits.

(*d*) Wipe off any lubricant seeping from the moving parts to prevent accumulation of dust and grit.

b. M5.—This range quadrant is used on the 75-mm gun carriage M2A3. It has provision for mounting an elbow telescope for direct laying of the piece in elevation.

51. Sight, bore.—The bore sight is used to indicate the direction of axis of bore of the gun for alinement and verification of sights.

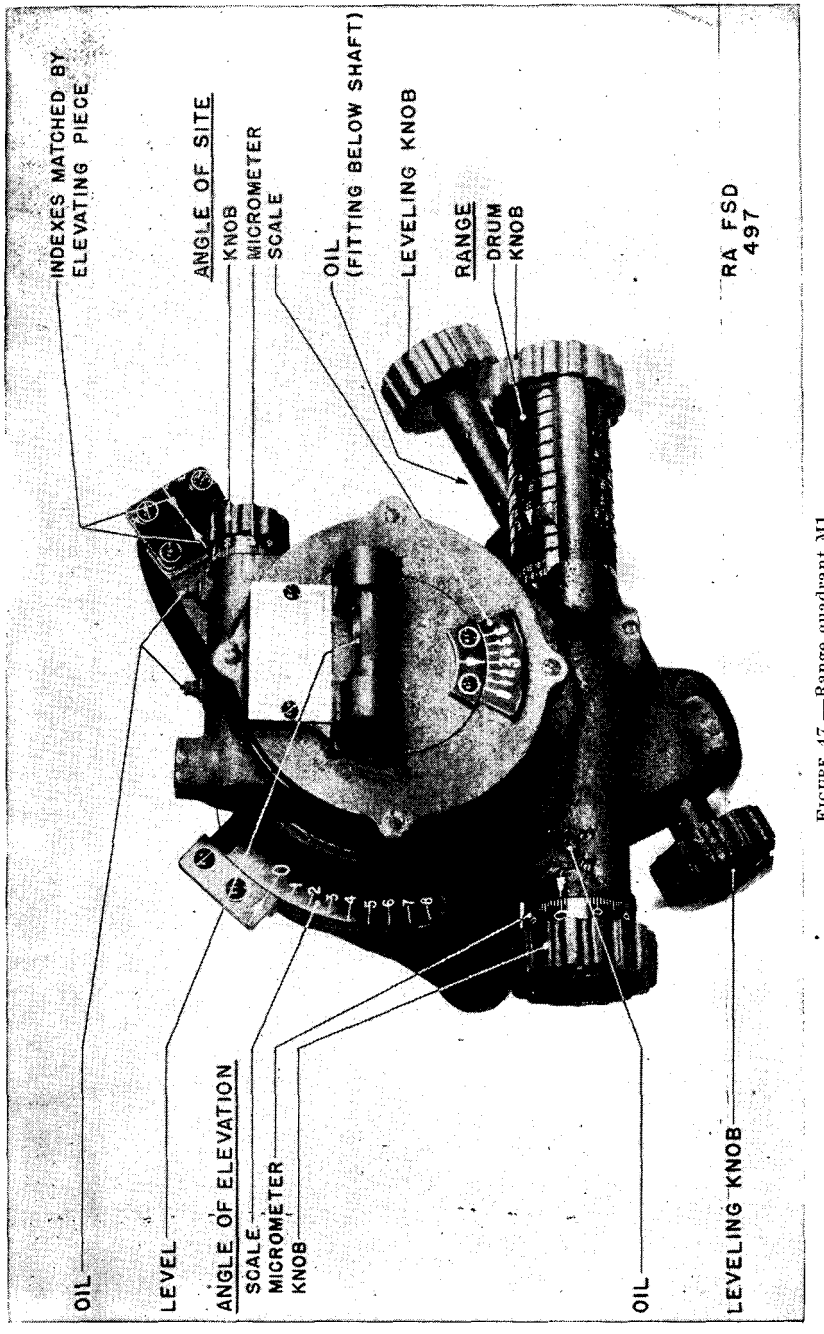


FIGURE 47.—Range quadrant M1.

Each bore sight is composed of a breech element and a muzzle element.

a. Description.—(1) The breech bore sight (fig. 48) is a disk which fits accurately in the breech chamber of the gun. Model of gun for which it is to be used is engraved on the disk.

(2) The muzzle bore sight includes a quantity of black linen cord to be stretched tightly across the muzzle vertically and horizontally in the score marks thereon, and a web belt to be buckled around the muzzle to hold the cord in place.

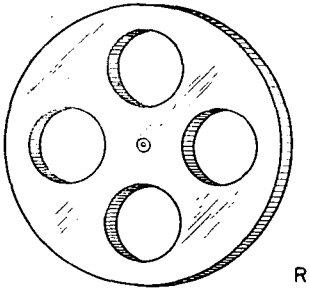


FIGURE 48.—Breech bore sight.

b. Operation.—With the two elements in place, look through the aperture in the breech bore sight. Direction of axis is indicated by the cord intersection.

c. Care and preservation.—Handle breech bore sight carefully to prevent nicks and burs. Wind the cord and web belt into a compact bundle when not in use.

52. Sight M1901 (French).—This sight (fig. 49), furnished with each 75-mm gun and carriage M1897MIA2 or M1897A4, is the element by which the piece is aimed in direction and laid or aimed to the correct angle of site. No correction for cant is applied.

a. Description.—The collimator, attached to a long shank with a removable extension, is arranged to be turned to any required value of azimuth or lateral deflection. The entire sight is elevated or depressed by the angle of site handwheel of the gun carriage, angle of site being introduced either directly (aimed fire) by means of the collimator line of sight, or indirectly (laid fire), using a level which is arranged to be inclined as required through a limited range. These sights are being equipped with the instrument light M3, operated from a flashlight cell and carried on the shield of the carriage.

b. Operation.—(1) To place the sight in service, remove cover from sight mount, uncover level, remove collimating sight from carrying

case, and place in socket of sight mount, taking care that forked projecting arm properly engages the mating parts. When aiming point is above or below the limits of the collimator, withdraw auxiliary collimator from its recess and turn it to the position shown.

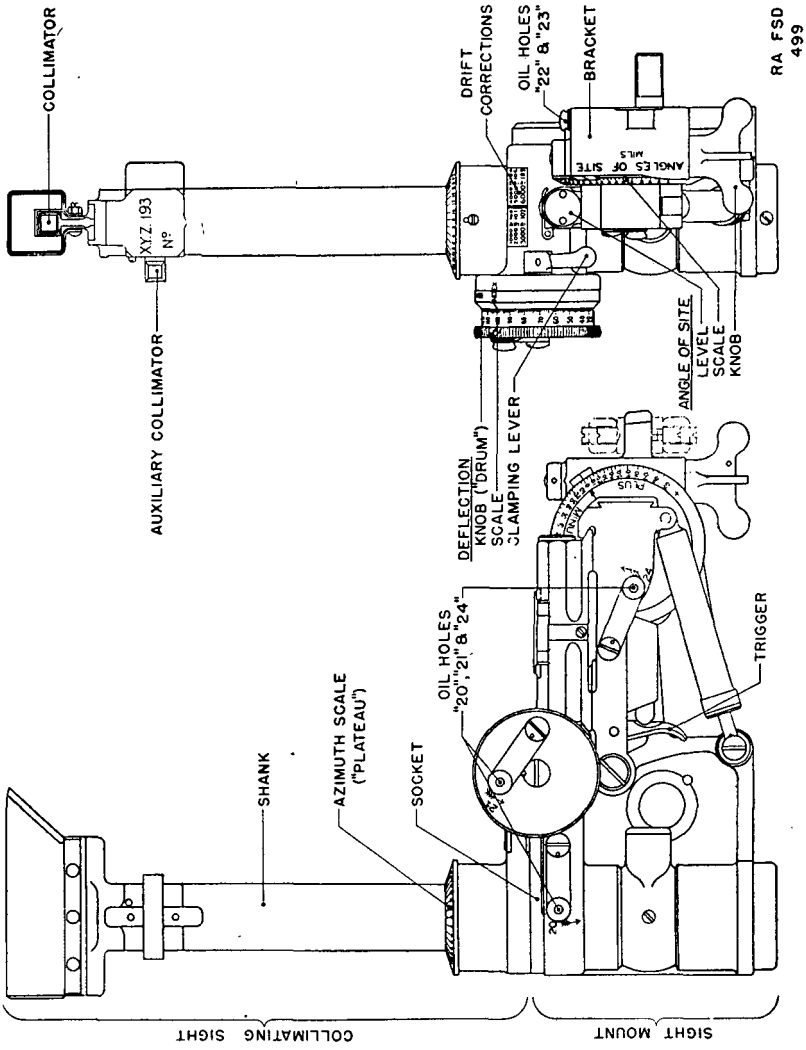


FIGURE 49.—Sight M1901 (French).

(2) Initial settings depend on whether direct or indirect laying is to be used. For indirect laying, settings of azimuth and angle of site are made. For direct laying, a setting of lateral deflection is made.

(3) Azimuth settings are made in two steps.

(*a*) "Coarse" settings are made on the azimuth scale (referred to as the "plateau") which is arranged to be set and read in steps of 200 mils. To make this setting, press down on shank until it is free to rotate, then turn it so as to bring index line thereon to desired graduation on azimuth scale and release.

(*b*) "Fine" settings are made using the deflection knob and the associated scale (referred to as the "drum"). A clamping lever is provided which must be tightened to prevent shifting of the setting during firing.

(*c*) The value of the setting is the sum of fine and coarse (drum and plateau) settings. Be certain that the proper quadrant is used when making azimuth settings, as four positions with the same angular indication are possible. The line of sight is parallel or perpendicular to a vertical plane through axis of bore when plateau is at zero and drum is at 100.

(*d*) To correct these settings to true azimuths as indicated on some fire-control instruments now in general use, subtract 100 mils. In the first quadrant, the result is the azimuth; in the second, third, or fourth quadrants, add 1,600, 3,200, or 4,800 mils, respectively.

(*e*) Azimuths as employed in this sight are measured in a slant plane through the target, not in a horizontal plane. The difference is usually negligible, except when the angle of site is large.

(4) Deflection settings are made in the same manner as azimuth settings.

(*a*) Note that a reading of 100 on the deflection scale corresponds to zero deflection angle.

(*b*) Increasing deflections (knob turned toward breech) on this scale displace the trajectory toward the left. Decreasing deflections (knob turned toward muzzle) displace it toward the right.

(*c*) An engraved table of deflections to correct for drift at various ranges is provided on the sight mount. As on the deflection scale, 100 mils corresponds to zero drift.

(5) Angle of site settings are required only when the piece is to be laid in angle of site.

(*a*) On instruments of French manufacture the angle of site scale and auxiliary level are calibrated in terms of the "infantry mil," a slightly larger unit than the standard American "artillery mil" (1/6400 of a circle). Sight mounts and levels are appropriately marked so that the unit can be readily ascertained. Conversion, when necessary, is as follows:

100 artillery mils = 98.2 infantry mils.
100 infantry mils = 101.8 artillery mils.

(*b*) For angles numerically less than ±100 mils use the angle of site level. For larger angles up to ±300 mils, remove angle of site level and substitute auxiliary angle of site level. A level is readily released by depressing the trigger and then removed by a slight forward movement. When auxiliary level is placed with the +200 inscription toward the rear, add 200 mils to scale indications. When it is placed with the −200 inscription toward the rear, subtract 200 mils from scale indications.

(*c*) Rotate angle of site knob until the desired indication appears on the associated scale. If auxiliary level is used, add or subtract 200 mils as noted above. Plus angles of site for targets above the piece; minus angles for targets below the piece. A zero indication corresponds to a level line of sight.

(6) To use the sight, place the eye approximately 10 inches to rear of collimator. When the eye is so placed, the cross of the collimator reticle will be seen. Move the eye so that the field of view is seen. To obtain a rapid alinement above or below the limits of the collimator, an auxiliary collimator with a vertical line only on the reticle is provided. In addition the cover over the collimator may be used as an open sight.

(7) (*a*) For direct laying, operate traversing and angle of site handwheels so that the reticle cross appears on the target. No setting of angle of site is required.

(*b*) For indirect laying, operate traversing handwheel so that vertical line of reticle cross is alined with aiming mark and operate angle of site handwheel so that angle of site level bubble is centered.

(8) The sight extension is to be used only when vision is obscured by the shield or other carriage part. It must be removed when the piece is fired and when traveling. It is readily installed by lifting collimating sight from sight mount socket, inserting the extension and collimating sight in a similar socket in the extension, taking care that the forked projecting arms properly engage with the mating parts.

(9) To prepare the sight for traveling, turn auxiliary collimator to vertical position and allow it to retract in recess provided, remove collimating sight and place it in carrying case, cover level, and place cover over sight mount.

c. Test and adjustment.—No adjustment of the sight by the using arm is permitted. The collimator line of sight and the angle of site level should however be frequently verified. This verification involves not only the sight itself, but also the proper alinement of

certain carriage parts and the minimizing of errors due to friction and lost motion therein. Full instructions are given below.

(1) Verification of the sight consists in ascertaining that—

(*a*) Optical axis of collimator is parallel to axis of bore of gun when range and azimuth scale index are at zero and deflection drum at 100.

(*b*) Axis of auxiliary collimator is in a plane parallel with line of fire under the same conditions.

(*c*) Angle of site level gives exactly the angle formed by axis of gun and a horizontal line when range is at zero.

(2) Before making the verification it is necessary to ascertain the trunnion "friction angle" to see that the trunnions are not prevented from rotating smoothly. If they do not work properly the rocker may be strained slightly and the sight bracket will not follow the movements of the gun promptly. See that rocker arms do not bind on the sides of the cradle.

(*a*) Set range at about 1,000 meters and angle of site at zero. These are the most desirable conditions, but range and angle of site can be at any graduation as long as these graduations are not changed during the operation.

(*b*) Center angle of site level bubble by slowly turning angle of site handwheel so as to depress the gun, being careful not to let bubble pass center of the level. In case bubble should pass center of the level, the breech must be completely lowered and the operations begun again.

(*c*) With level bubble centered place gunner's quadrant on leveling plates and read angle made by the gun with the horizontal. Leaving gunner's quadrant in place, give the handwheel two or three more turns so as to continue to depress the gun. Then reverse its motion and slowly elevate the gun until level bubble is again centered. Measure new angle of elevation. The difference between the two readings is the angular amount of lost motion in the trunnions and rocker.

(*d*) If lost motion or traction angle is less than ½ mil, conditions are good. They are acceptable if it does not exceed 1 mil. It should never be above 1 mil. If the friction angle is above 1 mil, trunnions and trunnion caps should be examined and an attempt made to remedy the defect as prescribed in cleaning and oiling of these parts.

(*e*) If it is impossible to bring the friction angle below 1 mil, it is useless to proceed with the further verification of the sight, and ordnance maintenance personnel should be notified.

(3) To verify angle of site level, set range and angle of site each at zero. Center level bubble by elevating the gun, using angle of site handwheel on gun carriage. Place gunner's quadrant on breech and read angle. Then, after elevating the gun farther, again center level bubble by depressing gun and read angle with gunner's quadrant. Take the mean of the two angles. Repeat the operations after replacing the angle of site level with the spare level. If the gun is in normal condition and levels in good condition, all angles will be close to zero. In no case should the mean of the readings made with each level be more than 1 mil from zero. If angle of site level does not meet the above prescribed test, it should be sent to ordnance maintenance personnel for repair.

(4) *To verify sight using testing target and bore sights.*—When time and facilities are available, a firm and properly leveled platform for the carriage can be prepared. Method of testing is as follows:

(*a*) Place carriage so that wheels and trail are resting on level ground.

(*b*) Traverse carriage to one side and place gunner's quadrant on axle. Block either wheel if necessary to level carriage transversely, and set brake.

(*c*) Insert breech bore sight in shell chamber, being sure it is perpendicular to axis of bore. Place muzzle bore sight cord in the lines and attach the belt.

(*d*) By means of elevating mechanism depress gun slowly until zero mark of range scale is opposite index on rear guide. Care should be taken not to pass the mark. If zero mark is passed, elevate gun again and proceed as before until zero mark is reached. The object of this is to take up all lost motion and friction in one direction.

(*e*) Place gunner's quadrant on leveling plates.

(*f*) By means of angle of site mechanism depress the gun slowly, centering level bubble. Care should be taken not to let bubble pass beyond center of the quadrant level.

(*g*) By means of traversing mechanism place carriage near center of axle.

(*h*) Place sight in its bracket, care being taken that it is seated properly. Be sure that sight and bracket are clean and free from dirt or grit. Set the azimuth (plateau) scale to zero and the deflection (drum) scale to 100.

(*i*) Place the testing target at a distance of about 50 yards in a plane perpendicular to the bore of the gun and at such a height that the axis of the bore passes through the center of the target marked "bore." The target can be hung vertically and checked by means of

a plumb bob. The target is moved until the vertical line through the targets on the right coincide with the plumb bob line. Raise or lower and move the target right or left until the axis of the bore sights coincides with the corresponding mark on the target. Do not release the carriage brakes to bring about coincidence.

(*j*) The collimator cross lines should fall on the point on the target marked "Sight M1901." If the vertical axis of the collimator falls to either the right or left of the vertical line of the target, it indicates that the deflection index is out of adjustment. If the horizontal axis of the collimator falls on the target above or below the horizontal line, it indicates that the bracket is out of adjustment. All adjustments necessary must be performed by ordnance personnel.

(5) *To verify sight without testing target.*—(*a*) To verify the sight for elevation proceed as follows:

1. Place carriage on level ground. Traverse carriage to one side and place gunner's quadrant on axle. Block up either wheel if necessary to level the gun.

2. Set range at zero. Point the gun by means of the bore sights at a sharply defined object not less than 1,000 meters distant and determine angle of elevation by means of gunner's quadrant placed on breech.

3. Aim collimator in elevation on the same object by means of the cross lines, first elevating gun and then depressing it. Determine angle of elevation of the gun each time by means of gunner's quadrant and take the average of the two readings.

4. If all parts are properly adjusted and in good condition, all the angles thus determined will be approximately equal. If any difference exists, the average of the two readings with the sight should not differ from the reading with the bore sights (first obtained) by more than 1 mil.

(*b*) To verify the sight for direction proceed as follows:

1. Place the gun in the middle of its slides. Force a screw driver between sweeper plate and wall of slide; force the gun to opposite wall; make a fine vertical mark across front of sweeper plate and front of cradle. Force the gun on opposite side with a screw driver. If mark on sweeper plate does not agree with that of the cradle, move the gun toward the middle by half the distance between the two marks.

2. Aim by means of bore sights on a sharply defined point at least 1,000 meters distant.

3. Aim on the same point by means of the sight with azimuth (plateau) scale set at zero, taking care to turn deflection knob (drum) only so as to increase the deflection. Note graduation indicated by drum. Aim again by turning deflection knob (drum) so as to decrease the deflection. Note new indication. In the first case start from drum graduation 0 and in the second case from graduation 200.

4. The difference between the two noted divisions must not exceed 5 mils, and both should be between the marks 96 and 104 on deflection drum.

5. Repeat the same operation with auxiliary collimator.

d. Care and preservation.—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Avoid striking or bumping any part of the instrument, particularly the locating surfaces of the levels, extension, and sight mount socket, which should also be kept clean, free from grit, and lightly coated with oil.

(3) About twice weekly oil sight mount using oil, lubricating, for aircraft instruments and machine guns. Five oil holes with swinging covers are provided for this purpose, designated by numbers 20 to 24, inclusive. Turn deflection knob as required to provide access to each of the two oil holes served by oil hole 21. Apply a few drops of oil occasionally on shank above the azimuth scale, at the same time pressing down on shank and turning it slowly.

e. Accessories and spare parts.—The carrying case for the collimating sight also contains space for a gunner's quadrant. The extension has a separate carrying case. A cover for the sight mount is provided. Spare parts, consisting of a collimating sight, level, auxiliary level, and carrying case, are provided. Parts of these sights are not interchangeable with similar parts of sights of different serial numbers and care must be taken that all parts pertaining to one serial number are kept together.

53. Target, testing.—A testing target is used during the bore sighting operation for the alinement of sights and subcaliber equipment with the axis of the bore of the piece. Four targets in an envelope are provided with each weapon. The aiming points corresponding to the axis of bore, subcaliber bore, and the lines of sight of such sighting equipment as may be applicable are plainly designated. It is essential that proper aiming points be selected for the matériel and equipment employed, and that the target be positioned vertically when in use.

SECTION II

FIRE-CONTROL EQUIPMENT

	Paragraph
Circles, aiming	54
Compasses	55
Finder, range, 1-m base, M1916	56
Setter, fuze, bracket, M1916	57
Table, firing	58
Telescope, battery commander's, M1915	59
Care and preservation of instruments	60

54. Circles, aiming.—*a. General.*—These instruments are for measuring lateral and vertical angles and for general topographical work.

b. M1916 and M1916MI.—(1) *Description.*—These two aiming circles (fig. 50) are of different manufacture but are similar in construction except for minor design features. Each instrument includes a 4.2-power fixed focus telescope with a laterally and vertically graduated reticle, a circular level, a declinator, elevating, orienting, angle of site, and azimuth mechanisms, and azimuth and elevation scales and micrometers. The instrument is furnished complete with tripod, stand, and two carrying cases.

(2) *Operation.*—(*a*) To set up the instrument, clamp tripod legs at desired length, embed them firmly in the ground, and tighten leg clamping levers. Place aiming circle on mount, level by means of ball-and-socket joint and circular level, and clamp joint when level bubble is centered. Swing shutter over telescope objective up so that the opening therein is in direction of line of sight.

(*b*) To orient the instrument, either a datum point of known azimuth or magnetic bearings may be used.

1. To orient on a datum point of known azimuth, set azimuth scale (100-mil steps) and micrometer (1-mil steps) to azimuth of datum point and turn orienting knob. For large angular changes, relocate instrument on spindle, using orienting clamping wing nut, until datum point appears on vertical cross line of reticle. The telescope may be elevated or depressed as required to bring point in field of view.

2. To orient on magnetic north, set azimuth scale (100-mil steps) and micrometer (1-mil steps) to indicate zero. Press needle release plunger and hold in place with catch provided. Turn orienting knob. For large angular changes relocate instrument on spindle, using orienting clamping wing nut, until arrow index lines of declinator

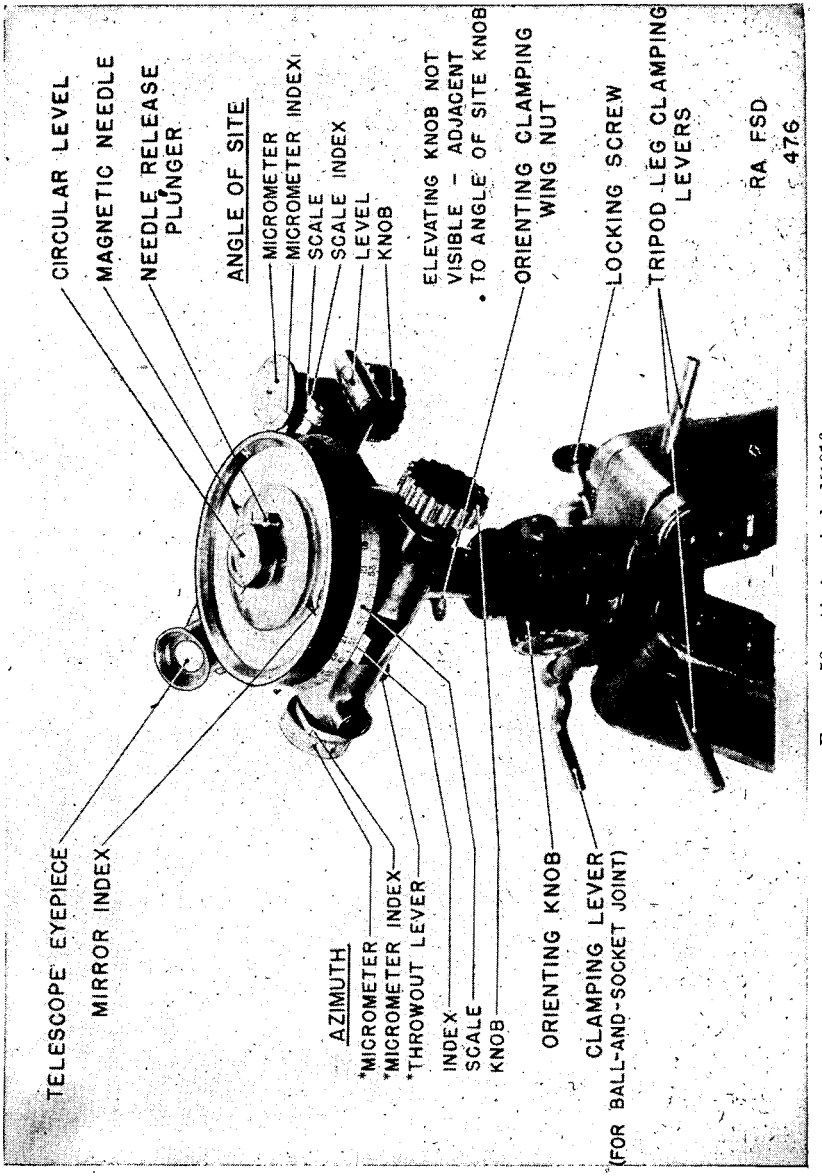


FIGURE 50.—Aiming circle M1916.

NOTE.—Aiming circle M1916MI is similar in appearance but parts indicated by an asterisk (*) are on the same end of the shaft as the knob.

are approximately alined with magnetic needle. Then bring south-seeking end of needle midway between parallel lines of mirror index. The instrument will then indicate magnetic azimuth.

3. To orient on grid north, proceed as for magnetic north but set azimuth to magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. When needle is alined with mirror index, the north end will point to east or west side of the N index mark, depending on whether declination is east or west. The instrument will then indicate grid azimuths.
4. When orientation by magnetic bearings has been completed, remove catch from needle release plunger, clamping needle.

(*c*) To read angle of site, rotate elevating knob so that object appears on horizontal cross line of reticle and then center bubble of angle of site level, using angle of site knob. The angle of site will then be indicated on angle of site scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight. The graduations along vertical line of reticle are spaced at 5-mil intervals and may also be used for measurement of angle of site up to ±85 mils. To make the 0 graduation correspond to a level line of sight, set angle of site scale and micrometer to normal (300 mils) and elevate or depress telescope to center level bubble.

(*d*) To read azimuth, bring object on verticle cross line of reticle using azimuth knob. The throw-out lever may be depressed to permit making large angular changes rapidly. Azimuth is then indicated on azimuth scale (100-mil steps) and micrometer (1-mil steps). For azimuths in the 3,200- to 6,400-mil region an auxiliary (upper) set of graduations on the scale is provided, indications thereon corresponding to those on panoramic telescopes with 0–3,200, 0–3,200 azimuth scales. Small angles may also be measured along the horizontal cross line of the reticle, which is graduated at 5-mil intervals.

(*e*) For use in darkness, a window is provided near the eyepiece of the telescope to be illuminated by external means not furnished with the instrument.

(*f*) To prepare instrument for traveling, swing down shutter over telescope objective. Be sure magnetic needle is clamped. Release orienting clamping knob. Remove aiming circle from mount and place it in carrying case. Do not remove mount from tripod.

(*g*) To use instrument in connection with a plotting board, place it on the stand provided instead of on the tripod. The stand has a fiducial edge permitting use of the aiming circle as an alidade.

(3) *Test and adjustment.*—(*a*) The azimuth scale and micrometer should indicate zero simultaneously. To make this adjustment, loosen the retaining screw in end of shaft, slip micrometer around as required, then tighten screw.

(*b*) Angle of site indication may be verified by sighting on a distant point at the same level as the telescope or at some other known angle. If the error is small, a correction may be applied by loosening retaining screw and slipping angle of site micrometer through required angle, then tightening screw. If angle of site scale and micrometer do not then read zero simultaneously, instrument should be turned in for adjustment.

(*c*) To check declinator it is necessary to set the instrument up in a position not subject to local magnetic attraction and sight on one or (preferably) more points of known azimuth. The average error should be noted and record made of necessary correction to be applied to future readings. No adjustment by the using arm is permitted.

(*d*) Ball-and-socket joint of mount should have a snug friction fit when the associated clamping lever is released. Excessive tightness or lost motion may be adjusted by means of the plug in the center of bottom of mount. This plug is locked by the retaining ring concentric therewith, which must be loosened for adjusting. Tighten retaining ring securely when adjustment is completed.

c. M1918 (French).—(1) *Description.*—(*a*) This instrument (figs. 51 and 52) includes a 4-power telescope with a laterally and vertically graduated reticle, two levels, a declinator, elevating, orienting, and azimuth mechanisms, and azimuth scales and micrometers indicating both in mils and in drum and plateau settings of the French sight M1901. No scale other than that on the reticle is provided for vertical angles.

(*b*) Instrument is furnished complete with tripod and carrying case.

(*c*) Aiming circles M1918 are being equipped with instrument light M4. This instrument light includes a battery case containing a single flashlight cell connected by flexible cords to a finger light and to a lamp housing which is arranged to be clamped to the aiming circle telescope for reticle illumination. The aiming circle carrying case is being modified to provide space for carrying the instrument light.

(2) *Operation.*—(*a*) To set up instrument, clamp tripod legs at desired length and embed them firmly in the ground. Clamp sliding support of tripod at desired height by means of clamping screw in tripod head. Level instrument, using circular level and ball-and-

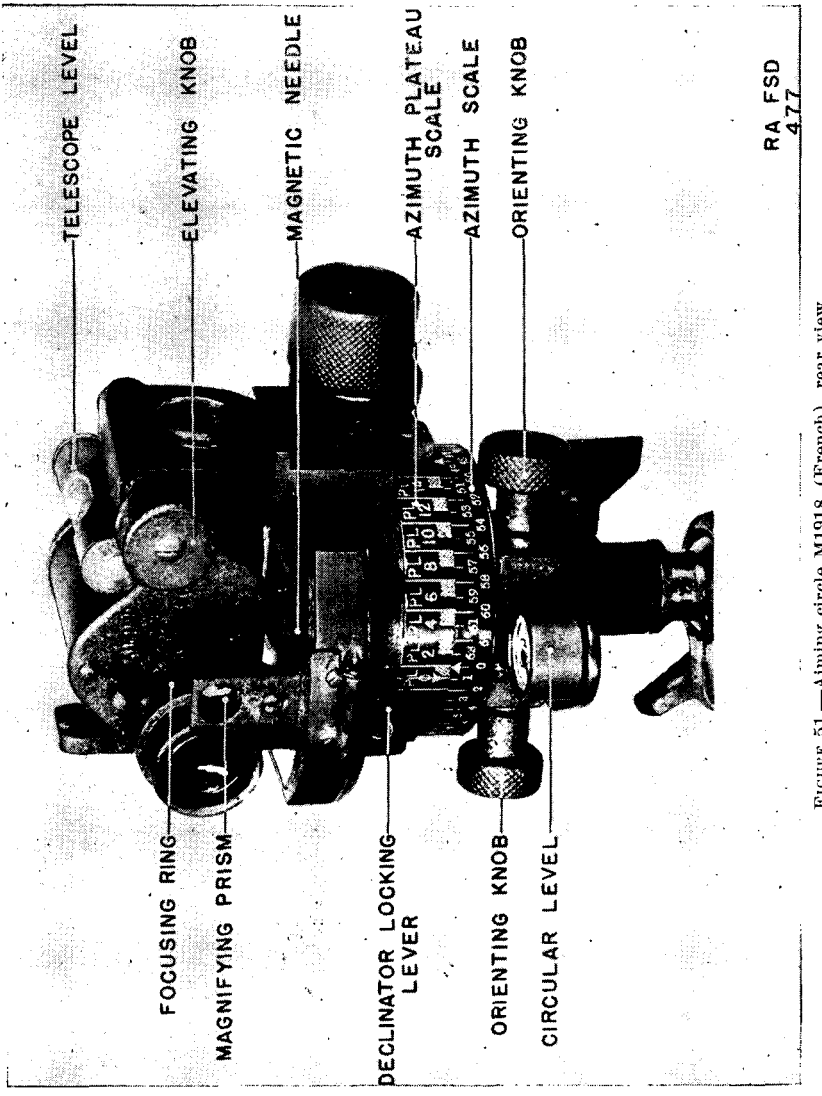


FIGURE 51.—Aiming circle M1918 (French), rear view.

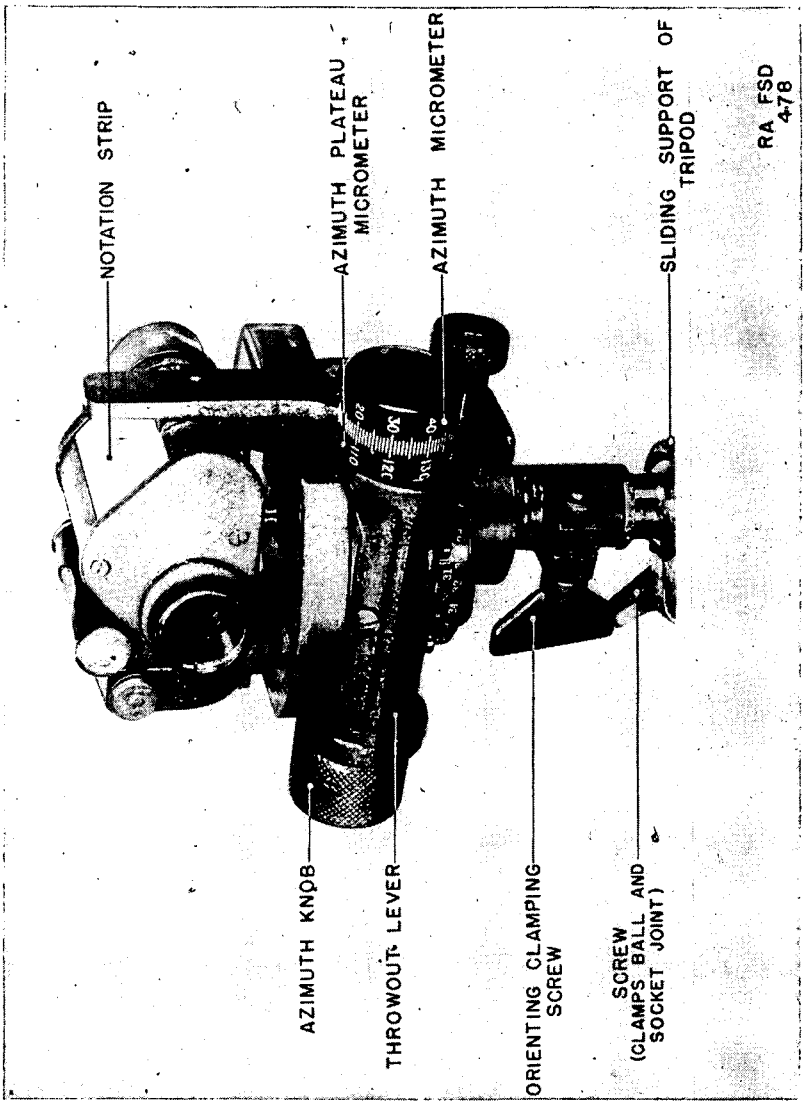


FIGURE 52.—Aiming circle M1918 (French), front view.

socket joint. Focus telescope as required, using focusing ring on eyepiece.

(*b*) To orient instrument, either a datum point of known azimuth or magnetic bearings may be used.

1. To orient on a datum point of known azimuth, set azimuth scale (100-mil steps) and micrometer (1-mil steps) to azimuth of datum point and turn one of the orienting knobs. The instrument may also be relocated on tripod spindle; using orienting clamping screw for large angular changes, until datum point appears on vertical cross line of reticle. The telescope may be elevated or depressed as required to bring point in field of view.

2. To orient on magnetic north, set azimuth scale and micrometer to indicate zero. Rotate declinator locking lever to permit magnetic needle to swing free. Turn one of the orienting knobs. The instrument may also be relocated on tripod spindle using orienting clamping screw for large angular changes so that the south-seeking end of the magnetic needle is in exact alinement with rear index of declinator as viewed through magnifying prism. Instrument will then indicate magnetic azimuths.

3. To orient on grid north, proceed as for magnetic north but set azimuth to magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. Instrument will then indicate grid azimuth.

4. When orientation by magnetic bearings has been completed, clamp needle by means of declinator locking lever.

(*c*) To read angle of site, rotate elevating knob so that bubble of telescope level is centered. The angle of site of an object is then indicated by its position on the graduations at 5-mil intervals along vertical cross line of reticle. Angles of site thus measured are limited to ±100 mils and no other indicating means are provided.

(*d*) To read azimuth, bring object on vertical cross line of reticle, using azimuth knob. The throw-out lever may be depressed for making large azimuth changes rapidly.

1. Azimuth indication of this instrument may be read either directly in mils or in terms of indications on the French sight M1901. Azimuths in mils are read directly on the azimuth scale (100-mil steps) and micrometer (1-mil steps).

2. Indications corresponding to those on the French sight (four 0–7,600 mil quadrants graduated in 200-mil steps) are read

on the azimuth plateau scale, read opposite one of the four index marks (at 0, 16, 32, and 48 graduations of azimuth scale). Only the even-numbered graduations on the azimuth plateau scale are read. Supplementary indications are the same as read on the deflection scale (drum) of the sight. When the index points into a clear space on the azimuth plateau scale, the supplementary indication is read on the azimuth micrometer (0–100 mils). When the index points into a cross-hatched space on that scale, the supplementary indication is read on the azimuth plateau micrometer. The two micrometers are read opposite different indexes. The azimuth plateau micrometer (upper) index bears cross hatching for ready identification.

3. Small angles may also be measured along the horizontal cross line of the reticle, which is graduated at 5-mil intervals.

(*e*) To prepare instrument for traveling, loosen ball-and-socket joint and place instrument in carrying case provided. Do not remove instrument from tripod.

(3) *Test and adjustment.*—(*a*) Azimuth and plateau micrometers should read 0 and 100, respectively, when azimuth scale indicates zero. The screw-in end of micrometer shaft may be loosened for this adjustment.

(*b*) The telescope level should indicate the line of sight determined by center of reticle to be horizontal. This may be verified by sighting on a distant point at the same level as the telescope, the error, if any, being read on the reticle. No corrective adjustment by using arm is permitted. A celluloid notation strip is provided on the telescope on which any correction should be recorded.

(*c*) To check accuracy of declinator it is necessary to set instrument up in a position not subject to local magnetic attraction and sight on one or (preferably) more points of known azimuth. The average error should then be noted and necessary correction recorded on notation strip. No adjustment by using arm is permitted.

d. M1.—(1) *Description.*—(*a*) This instrument (fig. 53) includes a 4-power telescope with a laterally and vertically graduated reticle, two levels, a declinator, elevating, orienting, and azimuth mechanisms, and azimuth scales and micrometers indicating azimuths both in mils and in terms of scale indications on other instruments commonly used therewith. No scale other than that on reticle is provided for vertical angles. Errors of 100 mils in deflection are often caused by reading the left-hand graduation on the plateau scale,

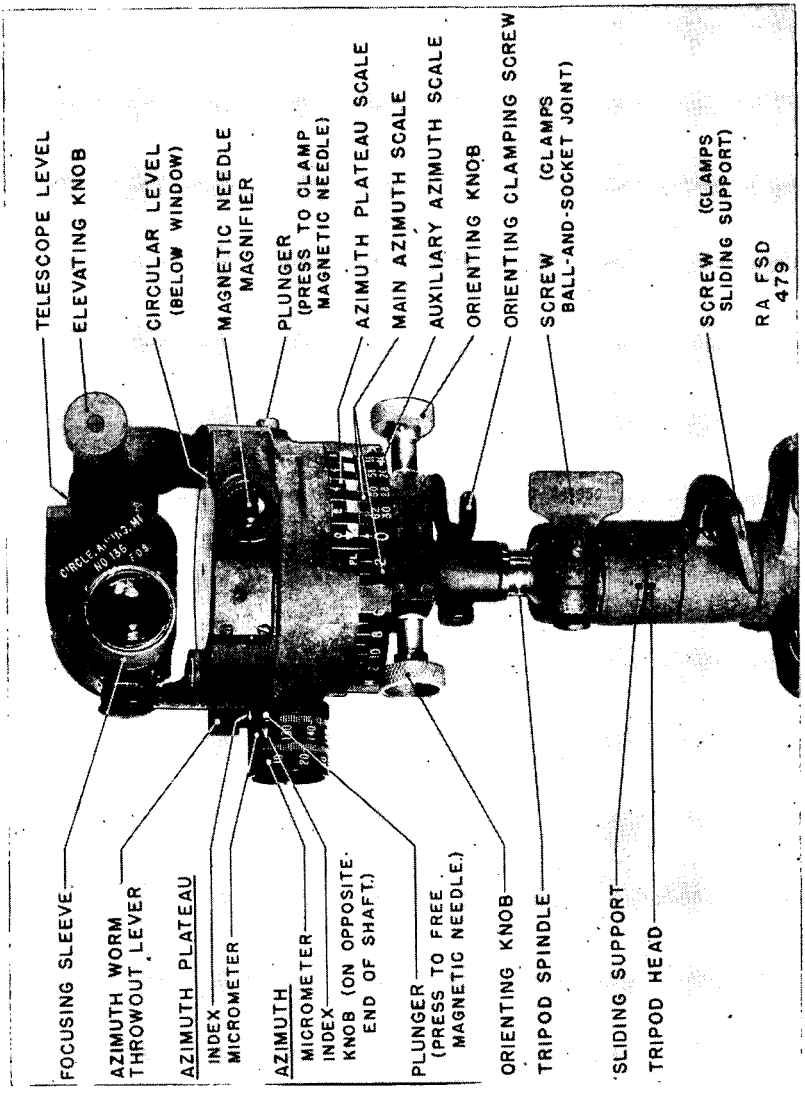


FIGURE 53.—Aiming circle M1.

instead of the index. The plateau scale consists of a quadrant subdivided into 200-mil spaces each halved, one-half being plain and the other cross-hatched. This scale is provided for use in conjunction with the sight M1901 (French) on the 75-mm gun carriages M1897A4 and M1897M1A2. The plateau scale can be removed to expose a plain index engraved on the body casting. Units armed with guns not equipped with sight M1901 (French) should remove the plateau scale from the aiming circle to eliminate confusion in making readings.

(*b*) Instrument is furnished complete with tripod and carrying case.

(*c*) Aiming circles M1 are being equipped with instrument light M2, which includes a battery case connected by flexible cables to a reticle unit and to a finger light. The battery case, containing one flashlight cell, is arranged to be clamped to a tripod leg and has a switch controlling both lamps simultaneously. The reticle unit snaps in place in a dovetailed slot over the reticle illuminating window. The finger light has a soft rubber housing and is held by a spring clip on the battery case when not in use. The aiming circle carrying case is being modified to permit storage of the flashlight cell separately from the battery case.

(2) *Operation.*—(*a*) To set up instrument, clamp tripod legs at desired length and embed them firmly in the ground. Clamp sliding support of tripod at desired height. Level instrument, using circular level and ball-and-socket joint. Focus telescope as required, using sleeve on eyepiece.

(*b*) To orient the instrument, either a datum point of known azimuth or magnetic bearings may be used.

1. To orient on a datum point of known azimuth, set main azimuth scale (100-mil steps) and micrometer (1-mil steps) to azimuth of datum point and turn one of the orienting knobs. The instrument may also be relocated on tripod spindle, using orienting clamping screw for large angular changes until datum point appears on vertical cross line of reticle. The telescope may be elevated or depressed as required to bring point in field of view.

2. To orient on magnetic north, set main azimuth scale and micrometer to indicate zero. Press plunger releasing magnetic needle and turn one of the orienting knobs. The instrument may also be relocated on tripod spindle, using the orienting clamping screw for large angular changes until the north-seeking (knife-edge) end of mag-

netic needle appears approximately opposite an index behind the letter N at front of instrument. Then refine setting so that the south-seeking (rectangular) end of needle is centered in reticle, viewed through the magnifier. Instrument will then indicate magnetic azimuths.

3. To orient on grid north, proceed as for magnetic north but set azimuth to magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. Instrument will then indicate grid azimuths.

4. When orientation by magnetic bearings has been completed, press the red plunger to clamp the magnetic needle.

(*c*) To read angle of site, rotate elevating knob so that bubble of telescope level is centered. The angle of site of an object is then indicated by its position on the graduations at 5-mil intervals along vertical cross line of reticle. Angles of site thus measured are limited to ±85 mils and no other indicating means are provided.

(*d*) To read azimuth, bring the object on vertical cross line of reticle, using azimuth knob. The throw-out lever may be depressed for making large azimuth changes rapidly. Azimuth indications of this instrument may be read either directly in mils or in terms of indications of other instruments commonly used in connection therewith.

1. Azimuths in mils are read directly on the azimuth scale, using the main (upper) graduations for values from 3,200 mils up. Indications on this scale are at 100-mil intervals and are supplemented by those on the azimuth micrometer, which is graduated at 1-mil intervals.

2. Angular indications corresponding to those on panoramic telescopes with 0–3,200, 0–3,200 mil scales are similarly read, auxiliary (lower) graduations for azimuths over 3,200 mils.

3. Angular settings to be set on the French sight M1901 are read on the aiming circle as follows:

(a) Use one of the graduations, 0, 16, 32, or 48, on the lower (azimuth) scale which is opposite the upper (azimuth plateau) scale as an index for reading the azimuth plateau scale.

(b) Check to make sure that the 0 to 1,600 mil quadrant of the French sight corresponds to the quadrant being read on the aiming circle.

(c) Read the nearest even numbered (200-mil) graduation on the upper scale of the aiming circle. This

value is to be set on the plateau scale of the French sight, which is also graduated in 200-mil steps.

(d) When the index points into a cross-hatched space, read the azimuth plateau micrometer (100–200 mils) as shown in figure 54. When the index points into a clear space, read the azimuth micrometer (0–100 mils). The value thus read on one of the aiming circle micrometers is set on the (fine) drum scale of the French sight, which is graduated from 0 to

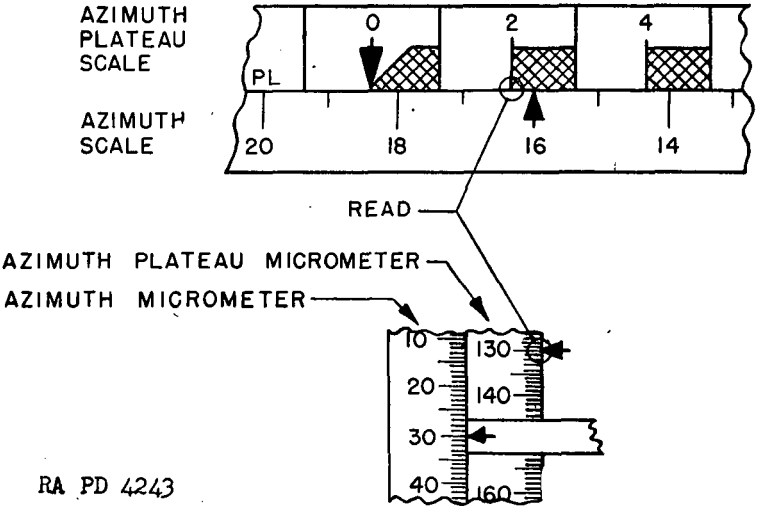


FIGURE 54.—Scales and micrometers on aiming circle M1, showing a reading of "Plateau 2—Drum 130" for the French sight M1901.

200 mils. It should be remembered that the normal position of the drum of the French sight is the 100-mil mark.

4. Small angles may also be measured along horizontal cross line of reticle, which is graduated at 5-mil intervals.

(*e*) To prepare instrument for traveling, loosen ball-and-socket joint and place instrument in its carrying case. Do not remove instrument from the tripod.

(3) *Test and adjustment.*—(*a*) Azimuth and plateau micrometers should read 0 and 100, respectively, when azimuth scale indicates zero. Three screws in end of azimuth micrometer may be temporarily loosened for this adjustment.

(*b*) The telescope level should indicate line of sight determined by center of reticle to be horizontal. This may be verified by sighting

on a distant point at the same level as the telescope, the error, if any, being read on the reticle. No corrective adjustment by the using arm is permitted. A celluloid strip is provided on the front of the instrument on which any correction should be recorded.

(*c*) To check accuracy of declinator it is necessary to set instrument up in a position not subject to local magnetic attraction and sight on one or (preferably) more points of known azimuth. The average error should be noted and necessary correction recorded on celluloid strip. No adjustment by the using arm is permitted.

e. Care and preservation.—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Exposed moving parts should be oiled occasionally with a small quantity of oil, lubricating, for aircraft instruments and machine guns. Interior parts are not to be lubricated. Wipe off excessive lubricant to prevent accumulation of dust and grit.

(3) When storing aiming circles equipped with instrument lights, remove flashlight cell from battery case and place it in the compartment of the aiming circle carrying case.

55. Compasses.—*a. Prismatic compass M1918 (Sperry).*—This instrument (fig. 55①) is used for measuring angles of site, clinometer angles, and magnetic azimuths. The prismatic compass M1918 (Sperry) will be used until the compass M2, which is the present standard, becomes available (see *b* below).

(1) *Description.*—This instrument is furnished complete with a carrying case but without tripod. The instrument includes a compass dial (green) carrying a magnetic needle and azimuth scales, a weighted clinometer dial (white), and a sighting system whereby angular indications may be read while observing the object.

(2) *Operation.*—(*a*) To measure angles of site, raise leaf sight and rear sight. Pull out clinometer wedge knob to permit free rotation of clinometer dial. Focus rear sight on clinometer (white) dial, sliding sight as required and clamping it in position with rear sight knob. Hold instrument with dials in a vertical plane, look through niche in rear sight, and elevate or depress instrument until object observed is in line with horizontal central vane of leaf sight. The angle of site, reflected in rear sight prism, will also be visible in the center of the field of view. The angle of site scale (outer scale on clinometer dial) is graduated at 5-mil intervals and numbered at 100-mil intervals. The 50-mil points are also marked. A 300-mil indication corresponds to a level line of sight, as on the corresponding scales of range quadrants. The clinometer wedge knob may be partially depressed to damp out oscillations. It must not be depressed when taking the reading.

(*b*) To measure azimuths, first operate the instrument in angle of site until the compass (green) dial is exposed at rear sight by cutaway portion of clinometer (white) dial. Depress clinometer wedge knob. Raise leaf sight and rear sight. Focus rear sight on compass (green) dial, sliding sight as required and clamping it in position with rear sight knob. Hold instrument in hand or support it on a convenient nonmagnetic body. Look through niche in rear sight and rotate instrument in azimuth until the object observed is in line with the vertical central vane of the leaf sight. The magnetic azimuth, reflected in rear sight prism, will also be visible in the center of the field of view. The compass dial is graduated at 10-mil intervals and numbered at 100-mil intervals. Additional numbering is provided in the 3,200–6,400-mil half of the scale to correspond to the numbering on azimuth scales of panoramic telescopes which are graduated 0–3,200 mils in this range. To damp out oscillations of compass dial, gently depress one of the locking plungers. Plungers must not be in depressed position when taking the azimuth reading.

(*c*) To use the instrument as a clinometer, pull out clinometer wedge knob and stand instrument, prism to the rear, on its support, on a straight portion of the piece which is parallel to the bore. The reading of clinometer scale, read opposite an etched line on clinometer reading window, is the elevation of the piece. The clinometer scale is graduated at 10-mil intervals and numbered at 100-mil intervals. A 300-mil reading indicates bore of the piece to be level. Sights should not be raised when using instrument only as a clinometer. The clinometer wedge knob may be partially depressed to damp out oscillations. It must not be depressed when taking the reading.

(*d*) To prepare instrument for traveling, push in clinometer wedge knob (clamping clinometer dial) and turn leaf sight down (clamping the compass dial). Lower and fold back rear sight, securing it in place with the catch. Place instrument in case provided.

(3) *Test and adjustment.*—Accuracy of azimuth and angle of site indications may be checked by sighting on datum points of known azimuth and elevation. When placed on a flat level surface the clinometer should indicate 300. No adjustment by the using arm is permitted.

(4) *Care and preservation.*—(*a*) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(*b*) When not in use keep leaf sight down clamping compass dial, and clinometer wedge knob depressed clamping clinometer dial, thus preventing injury to and excessive wear of their respective pivots.

(*c*) Observe particular care to prevent bending of the leaf sight parts.

(*d*) No lubrication of the instrument is required.

b. Compass M2.—(1) *General.*—The compass M2 (fig. 55② and ③) is a multiple-purpose instrument used for measuring angles of site, clinometer angles, and magnetic azimuths. It has been adopted as standard to replace the prismatic compass M1918 (Sperry), which has been reclassified as limited standard.

(2) *Description.*—The compass weighs about 8 ounces, and measures over-all about 2¾ by 2¾ by 1⅛ inches when closed. It consists of a compass and angle of site mechanism contained in a body with a hinged cover. When the cover is closed, it lifts the magnetic needle from its pivot and clamps it securely for traveling. The north-seeking end of the magnetic needle is painted white. The compass scale can be oriented on grid (Y) north for any locality. Front and rear sights, together with a mirror in the cover, permit measurements to be made while observing the object.

(3) *Accessories.*—The compass is furnished complete with carrying case M19. The case is velveteen-lined and has a leather loop on the back for carrying on the user's belt.

(4) *Operation.*—Compass operating positions are shown in figure 55④ and ⑤. The compass should be held as rigidly as possible to obtain the most accurate readings. The use of a sitting or prone position, a rest for the hands or elbows, or a solid support for the compass will help to eliminate unintentional movement of the instrument. When measuring angles in azimuth, the compass should be used away from steel or iron masses which would distort the local magnetic field. The time of oscillation of the magnetic needle can be shortened by partially depressing the needle locking pin, or the average position of the needle in its swing may be used. Practice in the operation of the compass greatly increases the proficiency and accuracy attained by the operator.

(5) *To measure angles in azimuth by reading reflected image of azimuth scale.*—Hold the opened compass in both hands at eye level, with arms braced against body and the rear sight nearest the eyes. Place the cover at an angle of approximately 45° to the face of the compass (fig. 55④) so that the reflected scale can be readily viewed. Level the instrument by means of the reflected circular level, sight on the desired object, and read the azimuth in the reflected image of the scale. The azimuth reading is indicated on the azimuth scale by the south-seeking (black) end of the compass needle. When sighting, hold hands rigid and turn body. The instrument can be

sighted by any of the methods below. More accurate readings result from the use of a longer sight base.

(*a*) Raise the rear sight holder approximately perpendicular to the face of the compass. Sight on the object through the opening in the rear sight holder and through the window in the cover (fig 55④). Keep the compass level and raise or lower the eye along the opening in the rear sight holder until the black center line of the window bisects the object and the opening in the rear sight.

(*b*) Fold the rear sight holder out parallel with the face of the compass, with the rear sight perpendicular to its holder. Sight through or over the rear sight and view the object through the window in the cover. If the object sighted is at a lower elevation than the compass, raise the rear sight holder as needed. The compass is correctly sighted when the compass is level and the operator sees the black center line of the window bisecting the rear sight and the object sighted.

(*c*) Raise the front sight and the extended rear sight assembly perpendicular to the face of the compass. Sight over the tips of the rear and front sights. If the object is above the line of sighting, fold the rear sight toward the eye as needed. The instrument is correctly alined when, with the level centered, the operator sees the tips of the sights and the center of the object sighted in coincidence.

(6) *To measure angles in azimuth by reading azimuth scale directly.*—(*a*) Hold the opened compass in both hands (at about waist level), braced against the body, with the rear sight away from the body. Open the cover until the mirror affords a clear image of the object sighted. Extend the rear sight and raise the rear sight assembly until it is approximately perpendicular to the face of the compass. Level the instrument by means of the circular level. Holding arms rigid with the instrument level, turn body until the center line on the mirror bisects the opening in the rear sight holder and the mirror image of the object sighted.

(*b*) Then read the azimuth indicated on the azimuth scale by the north-seeking (white) end of the compass needle.

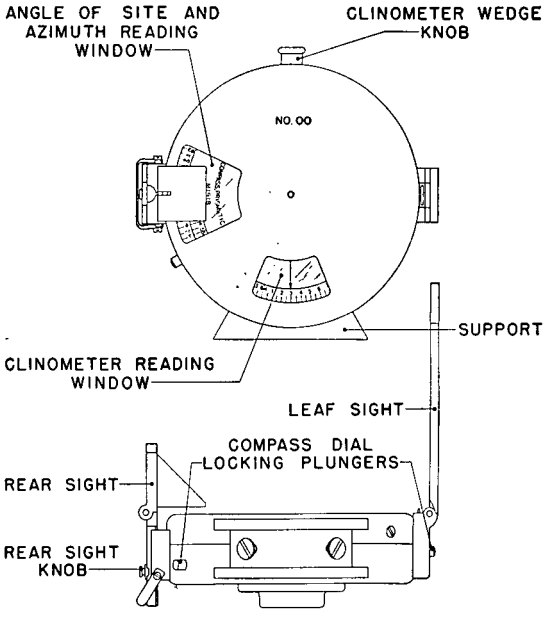
(7) *To measure angles of site.*—(*a*) Hold the opened compass in a vertical plane as in figure 55⑤ with the rear sight toward the body and the angle of site level lever to the right. Open the cover to an angle of approximately 45° to the face of the compass. Fold the rear sight holder out parallel to the face of the compass with the rear sight perpendicular to the holder.

(*b*) Look through the rear sight and raise or lower the instrument until the center line of the window bisects the opening in the rear sight and the object sighted.

(*c*) Then level the tubular level reflected in the mirror, by means of the lever. Open the cover and read the angle of site opposite the index.

(*d*) Care must be exercised to maintain the compass in a vertical plane to obtain accurate readings.

(8) *To measure clinometer angles.*—Open the cover and rear sight holder parallel with the face of the compass. Place the edge of the opened compass on the leveling plates of the piece, center the bubble of the tubular level, and read the angle of site.



① Prismatic compass M1918 (Sperry).

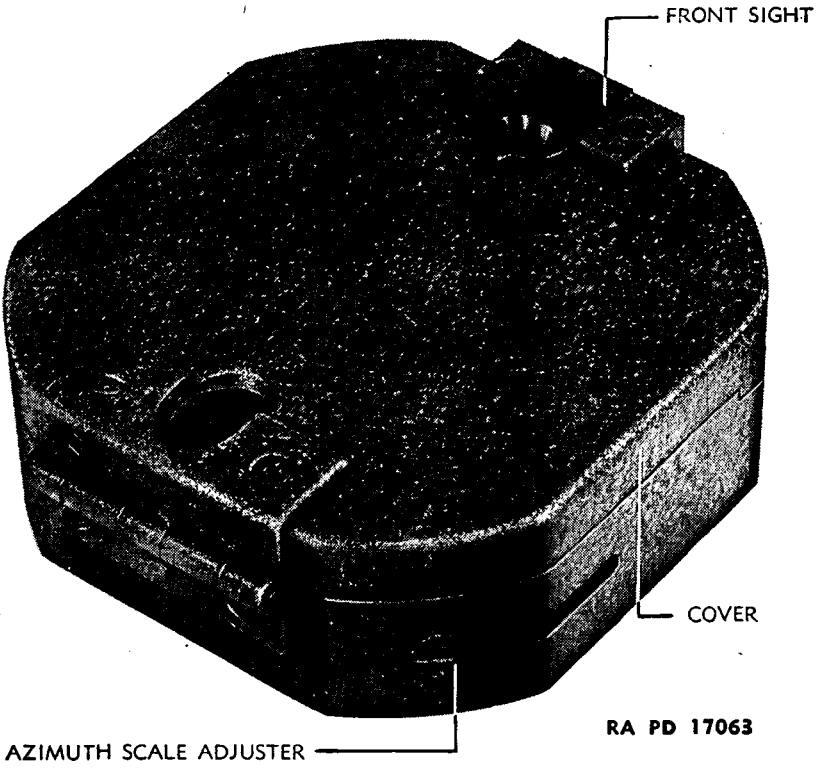
FIGURE 55.—Compasses.

(9) *Orientation on grid (Y) north.*—(*a*) The standard reference direction for compass readings is grid (Y) north, corresponding to the grid indications on standard maps. However, due to regional differences in magnetic direction and local disturbances in the magnetic field, the magnetic needle in the compass may point several degrees to either side of the reference direction. The difference between the magnetic direction and the standard reference direction is the declination constant.

(*b*) Allowance for declination constant can be made in this compass by orienting (shifting) the azimuth scale, using the azimuth scale

adjuster (fig. 55②). The slotted head of the adjuster can be turned with an ordinary screw driver.

(*c*) To determine the declination constant, open the compass and set zero of the azimuth scale against the fixed index in the body by means of the azimuth scale adjuster. Take compass readings on several points of known azimuth. Compute the difference between the compass reading (mean of three readings) of each of the points

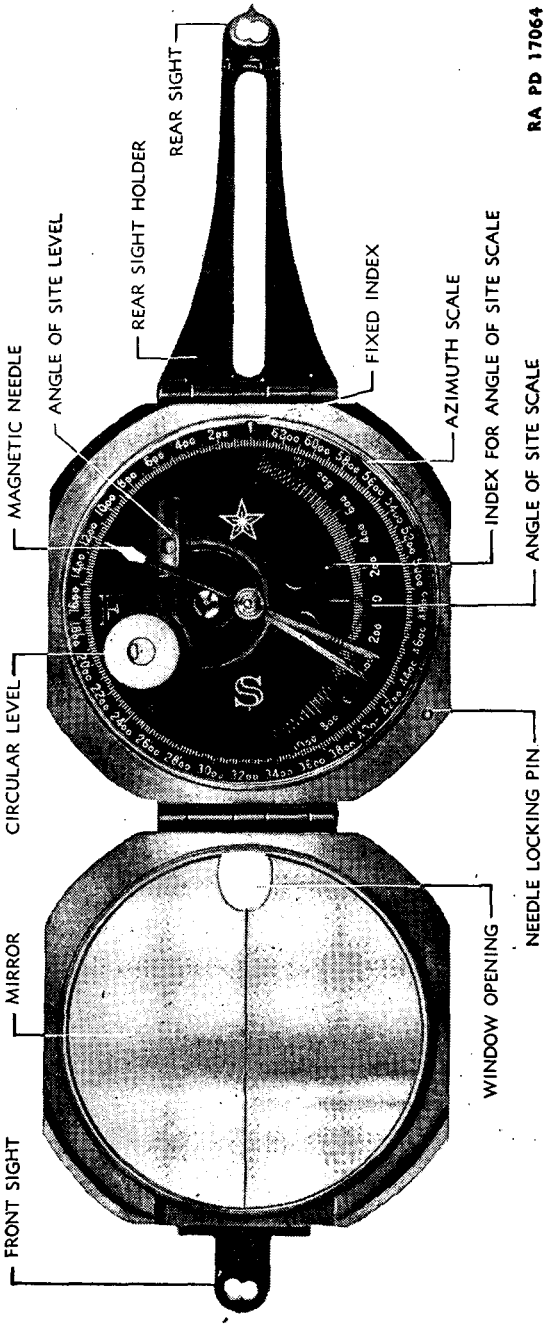


② Compass M2, cover closed.

FIGURE 55.– Compasses—Continued.

and the known grid (Y) azimuth. The mean of these differences is the declination constant of the instrument for the particular locality.

(*d*) If the azimuth readings are greater than the grid azimuths, subtract the declination constant from the azimuth readings or rotate the azimuth scale the amount of the declination constant in a counterclockwise direction by means of the azimuth scale adjuster. If the azimuth readings are less than the grid azimuths, add the declination

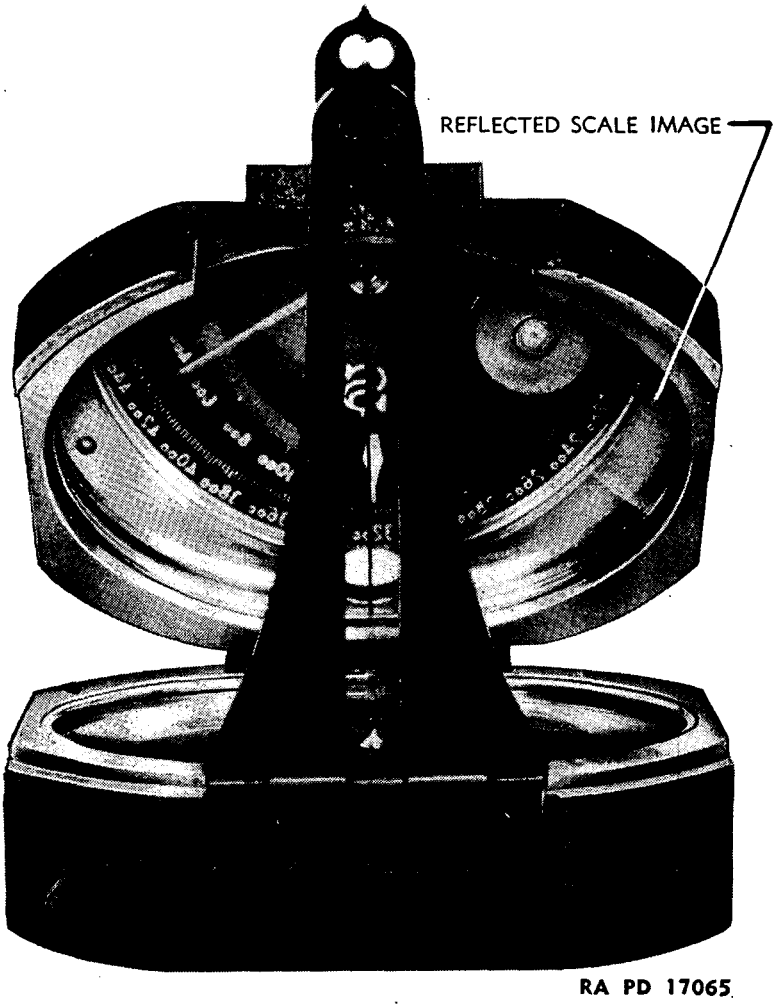


③ Compass M2, cover open.

FIGURE 55.—Compasses—Continued.

constant to the azimuth readings or rotate the azimuth scale in a clockwise direction. This orients the compass on grid (Y) north.

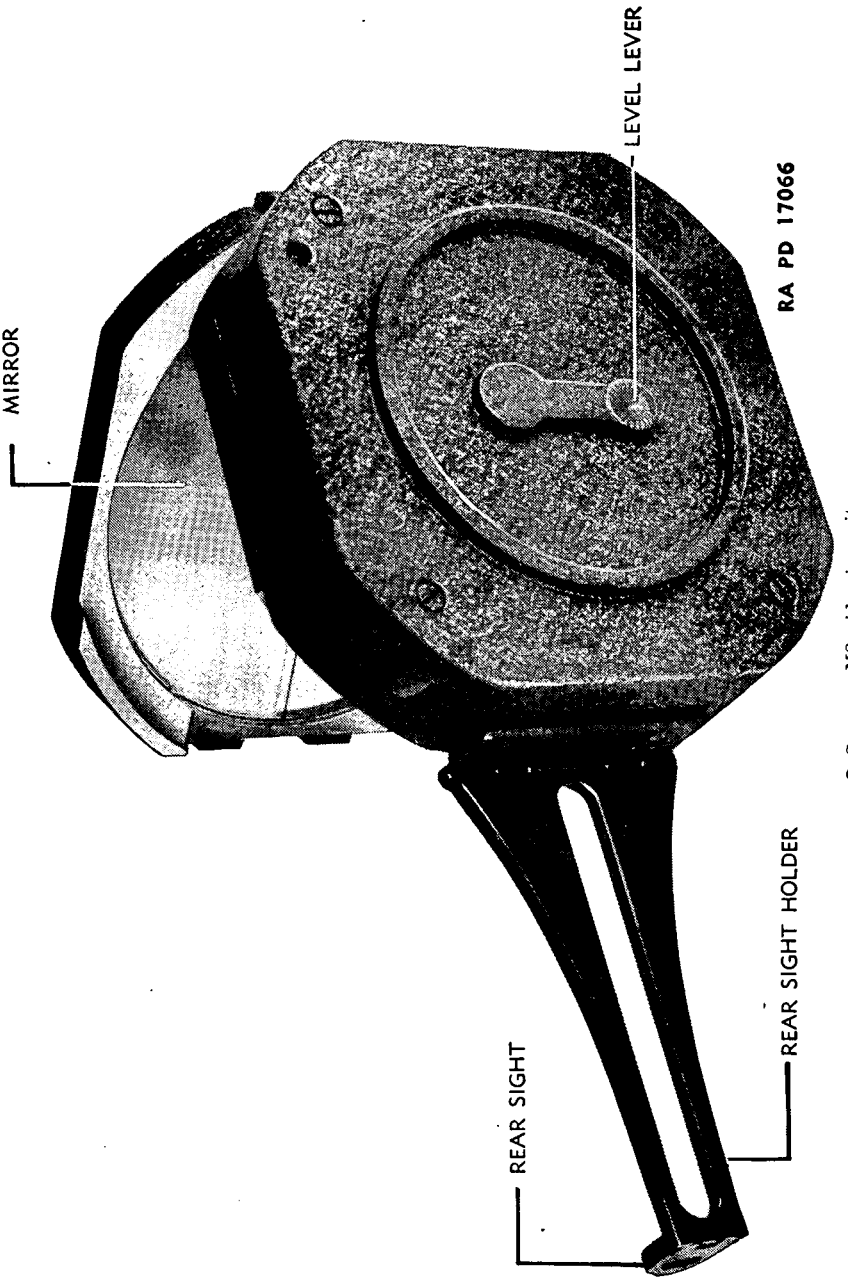
(*e*) An alternate method of finding the declination constant is to use an isogonic chart. This method is less accurate as it does not consider local disturbances in the magnetic field.



④ Compass M2, observer's view, azimuth.

FIGURE 55.—Compasses—Continued.

(*f*) If the compass is to be used in another locality 6 or more miles distant, the declination constant should be redetermined for that locality.



⑤ Compass M2, side view, site.
FIGURE 55.—Compasses—Continued.

(10) *Adjustment.*—Adjustment for dip of the magnetic needle and errors in the circular and tubular levels may not be made by using arms personnel. However, errors in the tubular level may be determined by comparison against a level or gunner's quadrant of known accuracy. If the error remains constant, it can be compensated for in measuring angles of site or when using the instrument as a clinometer.

(11) *Care and preservation.*—(*a*) The compass should be handled carefully to avoid unnecessary shocks. It should be closed and kept in the carrying case when not in use. After use in wet weather, the compass should be wiped dry before being placed in the carrying case.

(*b*) When the instrument is moved from one position to another, or is not in use, the cover should be closed, locking the needle off its pivot. This prevents injury to the needle pivot.

(*c*) Particular care should be exercised to prevent bending the sights or the cover hinge. Lay the rear sight flat before closing the cover.

(*d*) Moisture due to condensation may collect in the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by placing the instrument in a warm place.

(*e*) No lubrication is required.

56. Finder, range, 1-m base, M1916.—This instrument (figs. 56 and 57) is used primarily for measuring distance by triangulation. Indications of azimuth and angle of site are also provided.

a. Description.—The instrument includes an internal 1-meter base line, a 15-power optical system with two objectives and a common eyepiece of the coincidence type, and a scale on which the distance is indicated. It is furnished complete with mount and tripod. Necessary carrying cases and adjusting equipment are provided as accessories. The mount positions the line of sight of the range finder in elevation and azimuth and provides a hinge joint for placing the base line axis of the instrument in either a vertical or horizontal position. Angle of site and azimuth scales and micrometers are provided on the mount.

b. Operation.—(1) To set up the instrument, clamp tripod legs securely at desired length, embed them firmly in the ground, and tighten leg clamping levers. It is necessary that azimuth scale is in a substantially horizontal plane. Place range finder on mount and latch it in position. Position longitudinal axis horizontally and clamp with hinge clamping handle. Procedure for a vertical base line is described in (5) below.

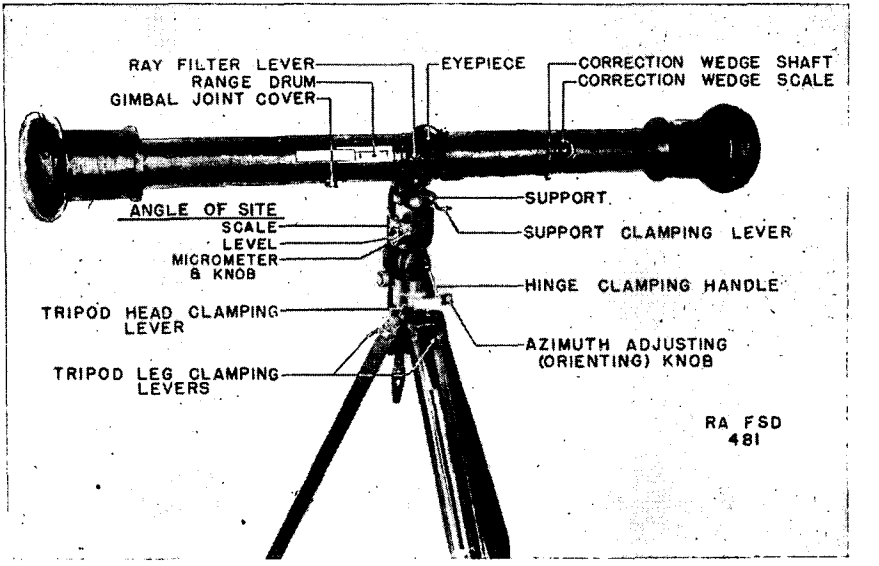


FIGURE 56.—Range finder M1916 1-m base, rear view.

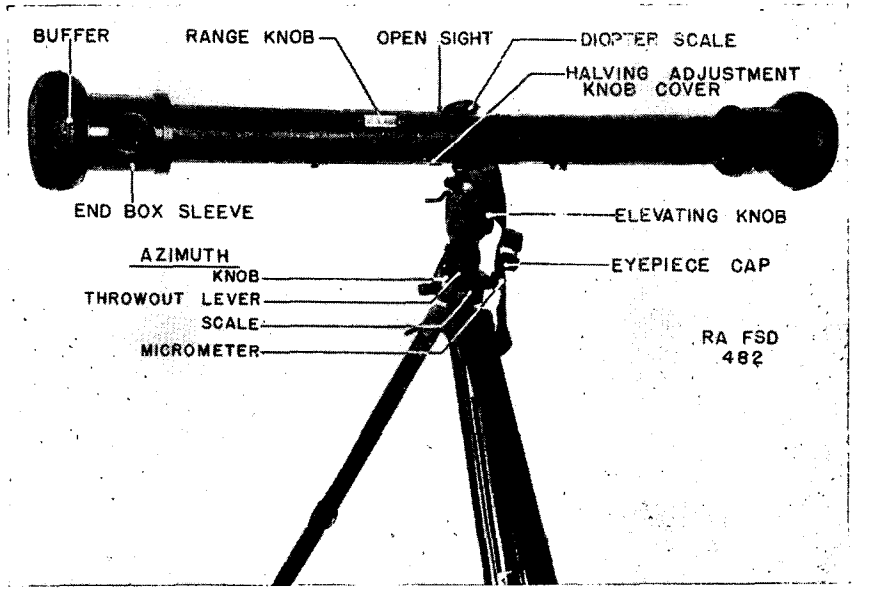
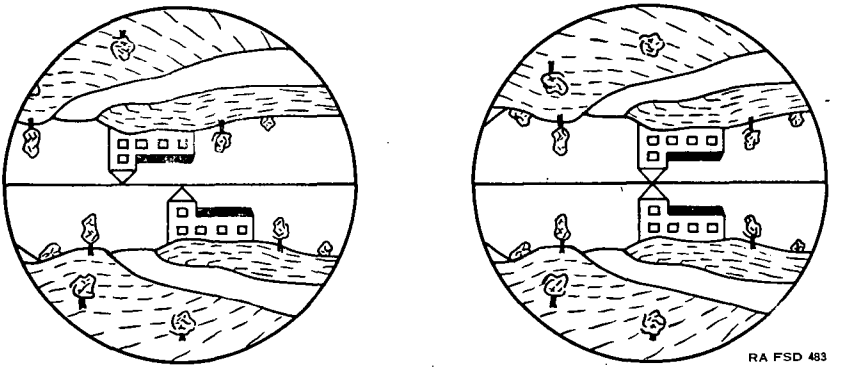


FIGURE 57.—Range finder M1916 1-m base, front view.

(2) To prepare optical system for use, rotate end box sleeves, uncovering both windows. Set ray filter lever to proper position. No filter at all may be used, or the amber filter (for exceptionally bright daylight or reflection of sun over water), or the smoked filter (for observation near the sun or into direct rays of a searchlight) may be employed. Focus eyepiece by rotating diopter scale to pro duce a clear image. If the operator knows the value for his own eye. the setting may be made directly on the scale.

(3) To orient the instrument, select a datum point of known azimuth. Set this value on azimuth scale and micrometer. Loosen tripod head clamping lever and swing instrument until datum point



① Not in coincidence. ② In coincidence.

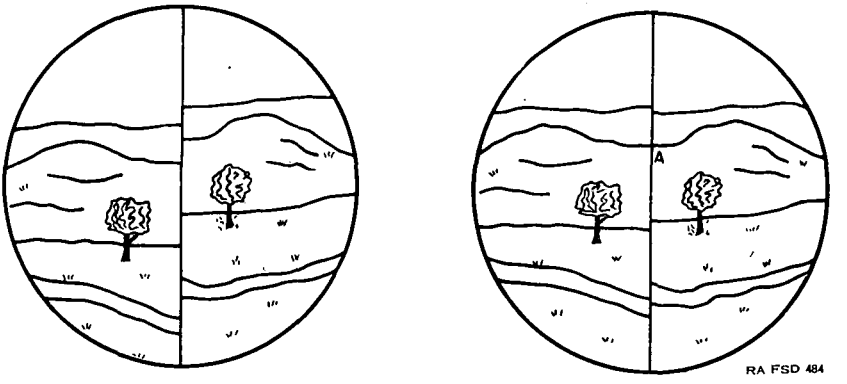
FIGURE 58.—Range finder field of view, horizontal base.

appears near vertical center line of field of view, indicated by a short line in lower field of view. Clamp lever and refine setting with azimuth adjusting (orienting) knob so that point appears exactly on vertical center line.

(4) To measure the range of an object, select a clearly defined part perpendicular, if possible, to the halving line. Move the instrument in azimuth and elevation as required to bring the part at center of field of view when in coincidence. On moving targets it is advisable to start with the target at edge of field of view so that it may be brought into coincidence as it crosses the field. An open sight is provided for picking up the target. For large angular displacements in azimuth, depress throw-out lever and turn instrument as required. When first observed images will ordinarily not be in coincidence (fig. 58①). Turn range knob until images of point selected appear in coincidence (fig. 58②). Read range in yards on range drum opposite sliding range pointer.

(5) To measure range of horizontal objects such as roads, trenches, crests of ridges, etc., which have no prominent vertical parts, turn instrument with longitudinal axis vertical, temporarily loosening hinge clamping handle for the purpose. Images when first observed will ordinarily not be in coincidence (fig. 59①). Turn the range knob until the image of horizontal line appears to continue across the halving line as at A in figure 59②. Temporarily lower the support clamping lever for any necessary motion in elevation (within limits of ±10°).

(6) To read angle of site, center level bubble, using angle of site knob. The angle of site indication may then be read on associated



① Not in coincidence. ② In coincidence at A.

FIGURE 59.—Range finder field of view, vertical base.

scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight. Angle of site can be read only when using the instrument with longitudinal axis horizontal.

(7) To read azimuth, the azimuth scale (100-mil steps) and micrometer (1-mil steps) furnish the necessary indications. It is essential that the plane of the azimuth scale be substantially level and that the object be at the center of field of view for correct angular indications. Azimuth may be measured with longitudinal axis either vertical or horizontal, but the instrument must be oriented separately for each position. Azimuths from 3,200 to 6,400 mils have an additional auxiliary scale reading from 0 to 3,200 mils for use with panoramic telescopes similarly graduated.

(8) To prepare instrument for traveling, cover the eyepiece, close the end box sleeves and the cover over range drum. Remove range finder from mount and place in its case. Place mount and tripod

in case, with elevating knob toward inside of case. Do not remove mount from tripod. Remove sight from adjusting lath. Place lath in internal pocket of tripod carrying case and sight in lid pocket. The latter pocket also contains the correction wedge key and a camel's-hair brush.

c. Test and adjustment.—(1) *Halving line.*—Incorrect adjustment of the halving line is indicated by failure of the corresponding points on inverted and erect images to fall on the halving line (fig. 60). To correct the halving, slide back cover exposing the halving adjustment knob and rotate knob until the corresponding point on each

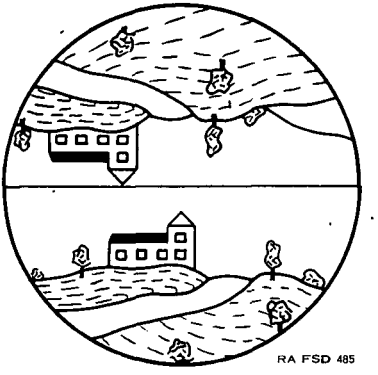


FIGURE 60.—Range finder field of view, incorrect halving.

image touches the halving line (as in fig. 58① and ②). A sharply defined point at least 400 yards away must be used for this adjustment. Return cover to its original position when adjustment is completed.

(2) *Range indication.*—(*a*) To test the instrument using a finite range, select a sharply defined object at a distance of 400 yards or more, the range of which is accurately known, and bring the object into coincidence in the center of field of view (fig. 58②). If range adjustment is correct, the known range should be indicated.

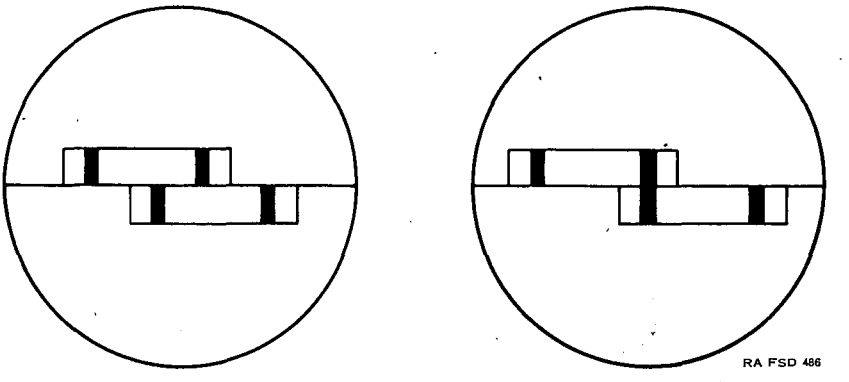
(*b*) To test using moon or other celestial body (never the sun), proceed as for an object at finite range. Infinite range (∞) should be indicated.

(*c*) To test the instrument by the infinity method, prepare adjusting lath by inserting the sight (carried in pocket flap of carrying case). Place adjusting lath in a horizontal position 200 yards or more from the instrument. Use the sight on the lath to insure perpendicularity to line of sight. Set range drum to indicate infinite range (∞). If images appear alined as in figure 61②, the adjust-

ment is correct. Misalinement, such as is shown in figure 61①, indicates necessity for adjustment.

(*d*) To adjust instrument in range, set range at the known range or at infinity, depending on the method of test employed, and bring images into correct relation, using the correction wedge key to turn correction wedge shaft. Note indication on correction wedge scale, repeat several times, and set the scale to the average of the readings.

(*e*) It is essential that the adjusting lath, when used, is the one belonging with the instrument. The same serial number is provided on both.



① Incorrect alinement. ② Correct alinement.

FIGURE 61.—Range adjustment, infinity method.

(3) *Azimuth indication.*—If azimuth scale and micrometer fail to indicate zero simultaneously, the latter may be slipped around as required, temporarily loosening clamping screw in the end.

(4) *Angle of site indication.*—Sight on a point at least 400 yards distant at the same level as the range finder. The angle of site indication should be normal (300 mils). Correction for small errors may be applied by slipping angle of site micrometer through required angle, temporarily loosening clamping screw in the end.

d. Care and preservation.—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Gimbal joint cover is not to be removed by using arm.

(3) Keep cover over the halving adjustment knob closed except when making an adjustment.

(4) Range finder should not be pointed directly at the sun. This instrument contains a cemented prism which will be injured by such practice.

(5) Avoid striking or bumping the instrument at the ends when mounted, as the parts at the center will thereby be subjected to excessive stress.

(6) Exposed moving parts of mount should be oiled occasionally using oil, lubricating, for aircraft instruments and machine guns. Interior parts of mount and range finder are not to be lubricated by using arm. Keep excess lubricant that seeps from the mechanism wiped off to prevent accumulation of dust and grit.

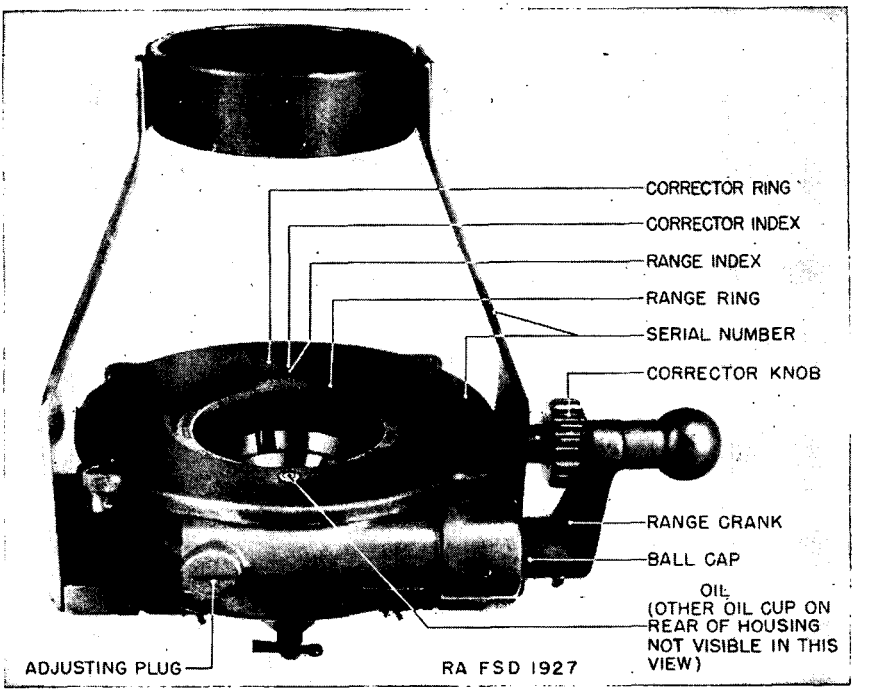


FIGURE 62.—Bracket fuze setter M1916.

57. Setter, fuze, bracket, M1916.—This fuze setter (fig. 62) is used for setting the 21-second fuze M1907M. It is furnished complete with cover.

a. Operation.—(1) Check to see that range ring corresponds to the gun and ammunition in use. This information is engraved on the range ring.

(2) Using the crank, set the desired value of range opposite range index. By means of corrector knob set desired value of corrector opposite corrector index. A setting of 30 corresponds to zero corrector.

(3) Insert round, fuze foremost, into the setter without regard to the relative position of fuze pins and setter parts. With round pressed firmly into the setter, rotate the round manually in a *clockwise* direction until a stop is encountered.

(4) Leave the round in setter until ready for use. Range or corrector may be changed with the round in place, the round then being turned clockwise again as in the original setting operation. Remove the round when ready for use, being careful not to change the fuze setting.

(5) To set a fuze to safe, set range at S, corrector at 30, and proceed as for other settings.

b. Test and adjustment.—(1) Accuracy of a particular fuze setter may be determined as follows: Set corrector to 30 and range to any convenient value, and set a fuze. The time set on the fuze should agree with the firing-table time of flight for the particular range. Several ranges should be used and a mean error determined. A false corrector may be applied to reduce the error.

(2) The only adjustments permitted the using arm are as follows:

(*a*) To eliminate looseness in either worm gear, loosen set screw and turn adjusting plug clockwise. Retighten set screw. Range crank should not fall of its own weight.

(*b*) To eliminate end play in either worm shaft, remove range crank or corrector knob by driving out taper pin, loosen set screw, and tighten ball cap with a teat wrench. Retighten set screw. Replace range crank or corrector knob and taper pin.

c. Care and preservation—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Occasionally oil the mechanism with oil, lubricating, for aircraft instruments and machine guns in the two oil cups provided. Set range to zero when oiling.

(3) Rotate the round only in a clockwise direction. Incorrect settings and loosening of the fuze may result from failure to do so.

(4) If the setter becomes clogged with sand or dirt so as to affect its operation, it is to be turned over to qualified ordnance personnel for cleaning.

(5) When not in use, protect the setter with its cover.

58. Table, firing.—The firing table is a pamphlet presenting in tabular form the exterior ballistic data for the weapon and its ammunition.

59. Telescope, battery commander's, M1915.—This instrument (figs. 63 and 64) is a 10-power binocular instrument used for observation and for measurement of azimuth and angle of site.

a. Description.—(1) The instrument complete includes a binocular telescope, mount, tripod, and as accessories the necessary carrying cases, storage chest, and cleaning brushes.

(2) Modified instruments to be designated M1915A1 will be equipped for reticle illumination and will be designed to receive the instrument light M1. Illumination of such instruments may

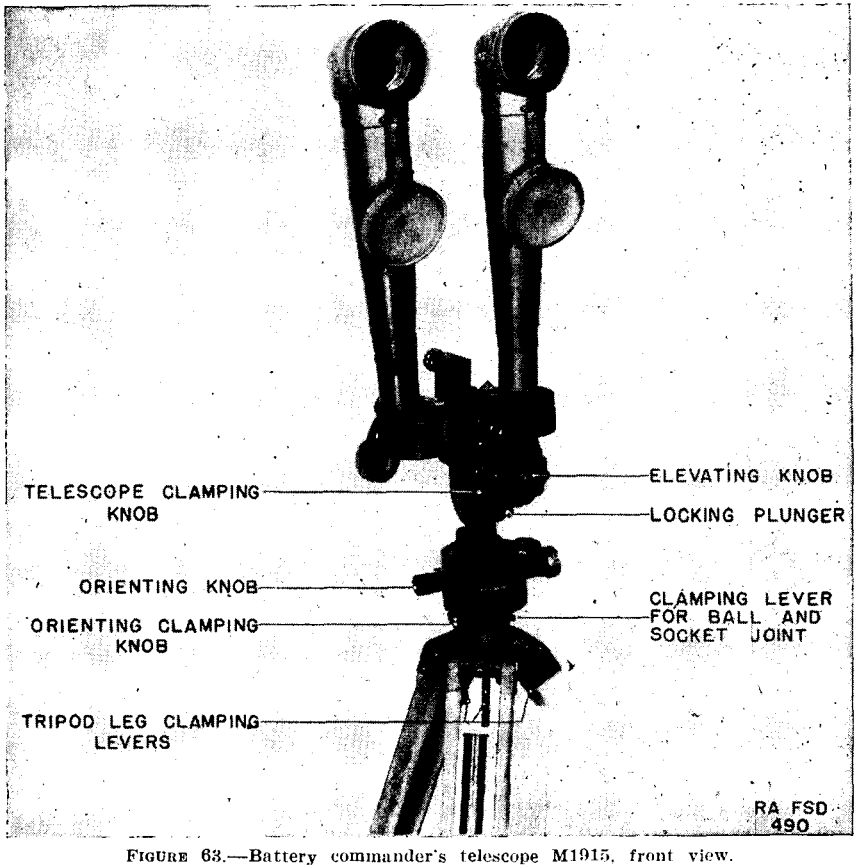


FIGURE 63.—Battery commander's telescope M1915, front view.

be supplied by flashlight until such time as the instrument light becomes available.

(3) Telescopes are arranged so that they may be positioned vertically, as shown, or swung down horizontally.

b. Operation.—(1) To set up the instrument, remove tripod and mount from tripod carrying case, clamp tripod legs at desired length, embed them firmly in the ground, and tighten leg clamping

levers. Remove telescope from its carrying case and place it on the vertical spindle extending from the mount, depressing locking plunger and turning telescope until mating surfaces of telescope and mount engage properly, then release plunger. Level the mount, using

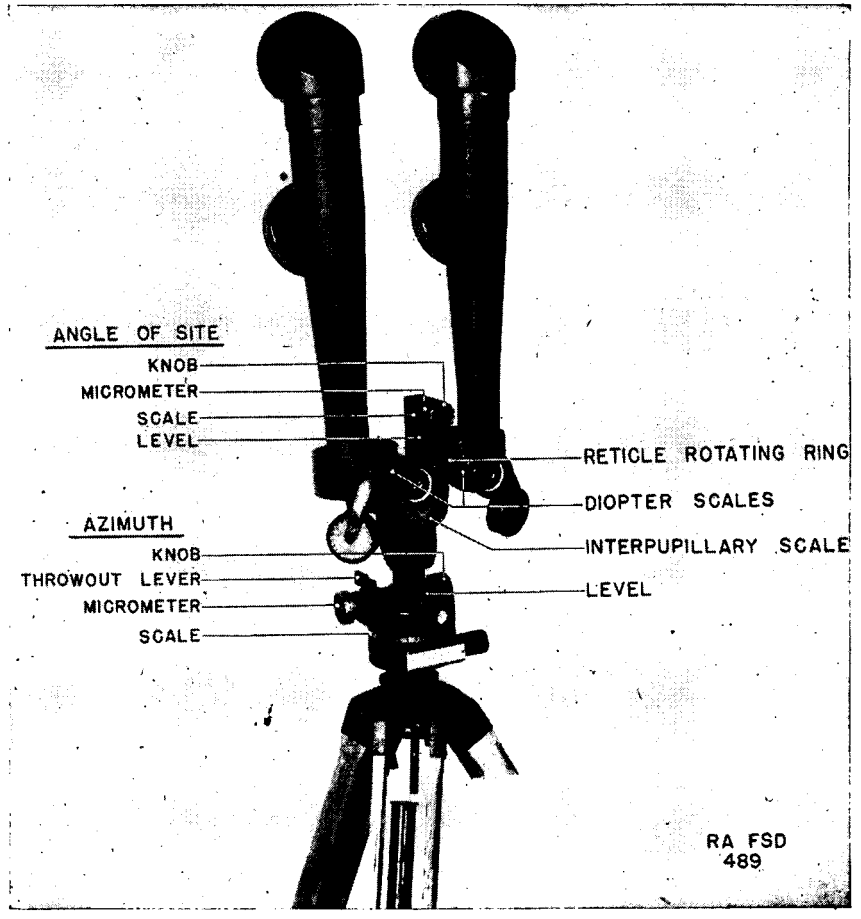


FIGURE 64.—Battery commander's telescope M1915, rear view.

the circular level and ball-and-socket joint at bottom of mount, and clamp with the lever when level bubble is centered.

(2) To prepare the telescope, remove caps from eyepieces and objectives. If required, place sunshades over objectives and amber filters over eye lenses. Sunshades and filters are carried in compartments of the telescope case. Release telescope clamping knob and turn telescopes to vertical or horizontal position as required, at the

same time setting proper interpupillary distance in millimeters on associated scale, and clamp in place. If interpupillary distance for observer is not known it may be found by observing the sky and moving eyepieces apart or together until field of view changes from two overlapping circles to one sharply defined circle. Focus each eyepiece independently, looking through telescope with both eyes open at an object several hundred yards away, covering the front of one telescope and turning diopter scale until object appears sharply defined, then repeating for other eye. A diopter scale is provided for each eye and if observer remembers the values for his own eyes, settings may be made directly on the scales. Turn reticle rotating ring until reticle appears erect.

(3) To orient the instrument, select a datum point of known azimuth and set this value on azimuth scale (100-mil steps) and micrometer (1-mil steps). The throw-out lever may be used to disengage the worm drive for making large changes in azimuth rapidly. Turn telescope by means of orienting knob until datum point appears at the center of reticle of right-hand telescope. The orienting clamping knob may be released temporarily for making large angular changes rapidly. Thereafter use only the azimuth knob or for large changes the azimuth throw-out lever, and correct azimuth of point observed will be indicated. For azimuths in the 3,200–6,400-mil region additional numbers (0–3,200 mils) are provided corresponding to azimuth scales on panoramic telescopes and other instruments.

(4) To read angle of site, swing angle of site mechanism into a substantially vertical plane. Direct telescope on the object and rotate elevating knob until object appears at center of reticle. By means of angle of site knob, center bubble of angle of site level in its vial. The angle of site is then read on angle of site scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight.

(5) The horizontal axis of the reticle is graduated at 5-mil intervals for 30 mils on each side of center. The two short lines above horizontal line are spaced 3 mils apart.

(6) To prepare instrument for traveling, remove sunshades and filters, if used, and place them in pockets of telescope carrying case. Cover objectives and eyepieces. With telescope shanks in a vertical position, press locking plunger and lift telescope from mount. Loosen telescope clamping knob and swing elevating mechanism against right- or left-hand telescope. Instrument will then fit snugly into the blocking of the case. Do not remove mount from tripod. Tripod leg clamping levers should not protrude.

c. Test and adjustment.—(1) Azimuth micrometer and azimuth scale should read zero simultaneously. The screw in the end of the micrometer may be loosened temporarily to permit slipping micrometer to desired position.

(2) Angle of site mechanism may be checked by observing a datum point of known angle of site. Small errors may be corrected by temporarily loosening screw in the end of knob and slipping micrometer and knob to correct position. If angle of site scale and micrometer then fail simultaneously to indicate 3 and 0, respectively, instrument should be turned in for adjustment by authorized ordnance personnel.

(3) Ball-and-socket joint of the mount should have a snug friction fit when associated clamping lever is released. Excessive tightness or lost motion may be adjusted by means of the plug in the center of bottom of mount. This plug is locked by the retaining ring concentric therewith, which must be loosened for adjusting. Tighten retaining ring securely when adjustment is completed.

d. Care and preservation.—(1) See paragraph 60 for general instructions pertaining to care and preservation of instruments.

(2) Exposed moving parts should be oiled occasionally with a small quantity of oil, lubricating, for aircraft instruments and machine guns. Interior parts are not to be lubricated by the using arm. Keep excess lubricant that seeps from the mechanism wiped off to prevent accumulation of dust and grit.

60. Care and preservation of instruments.—*a. General.*—(1) The instructions given below supplement instructions pertaining to individual instruments included in this chapter.

(2) Fire-control and sighting instruments are in general rugged and suited for the purposes for which they have been designed. They will not, however, stand rough handling or abuse; inaccuracy or malfunctioning will result from such mistreatment.

(3) Under no circumstances will a hose, either normal or high-pressure, be used in cleaning any sighting equipment or any fire-control instruments. Before washing, removable sighting equipment should be taken off the matériel to be cleaned. In cases where it is not removable, care will be taken to cover the parts properly.

(4) Disassembly and assembly by the using arm is permitted only to the extent authorized in the paragraphs pertaining to the individual instruments. Unnecessary turning of screws or other parts not incident to the use of the instrument is expressly forbidden.

(5) Keep the instruments as dry as possible. Never put a wet instrument in its carrying case.

(6) When not in use, keep the instruments in the carrying cases provided, or in the condition indicated for traveling.

(7) Any instruments which indicate incorrectly or fail to function properly after the authorized tests and adjustments have been made are to be turned in for repair by ordnance personnel. Adjustments other than those expressly authorized in the paragraphs pertaining to the individual instruments are not to be performed by the using arm.

(8) No painting of fire-control equipment by the using arm is permitted.

(9) Many worm drives have throw-out mechanisms to permit rapid motion through large angles. When using these mechanisms, it is essential that the throw-out lever be fully depressed to prevent injury to the worm and gear teeth.

(10) When using a tripod with adjustable legs, be certain that the legs are clamped tightly to prevent possibility of collapse.

(11) When setting up tripods on sloping terrain, place two legs on downhill side to provide maximum stability.

b. Leather articles.—Care and preservation of leather articles are covered in paragraph 38.

c. Optical parts.—(1) To obtain satisfactory vision, it is necessary that the exposed surfaces of the lenses and other parts be kept clean and dry. Corrosion and etching of the surface of the glass, which greatly interfere with the good optical qualities of the instrument, can be prevented or greatly retarded by keeping the glass clean and dry.

(2) Under no conditions will polishing liquids or pastes be used for polishing lenses and windows.

(3) For wiping optical parts use only paper specially intended for cleaning optical glass. Use of cleaning cloths in the field is not permitted. To remove dust, brush glass lightly with a clean camel's-hair brush. Rap brush against a hard body in order to knock out the small particles of dust that cling to the hairs. Repeat this operation until all dust is removed. With some instruments an additional brush with coarse bristles is provided for cleaning mechanical parts. It is essential that each brush be used only for the purpose intended.

(4) Exercise particular care to keep optical parts free from oil and grease. Do not wipe lenses or windows with the fingers. To remove oil or grease from optical surfaces, apply ethyl alcohol with a clean camel's-hair brush and rub gently with clean lens paper. If alcohol is not available, breathe heavily on the glass and wipe off with clean lens paper. Repeat this operation several times until clean.

(5) Moisture due to condensation may collect on optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture if not excessive can be removed by placing the instrument in a warm place. Heat from strongly concentrated sources should never be applied directly as it may cause unequal expansion of parts resulting in breakage of optical parts or inaccuracies in observation.

d. Lubrication.—Lubricants authorized for use in the paragraphs pertaining to the individual instruments are covered by the following specifications:

Oil, lubricating, for aircraft instruments and machine guns.
Grease, special, low temperature.

CHAPTER 4

AMMUNITION

	Paragraph
General	61
Classification	62
Identification	63
Painting and marking	64
Weight zone markings	65
Care and preservation	66
Authorized rounds	67
Fuzes	68
Point detonating fuzes	69
Combination fuze, 21-second, M1907M	70
Packing	71
Subcaliber	72

61. General.—*a. Form issued.*—Ammunition for the 75-mm guns M1897 and modifications is issued in the form of "fixed" rounds, either unfuzed or as fuzed complete rounds. A complete round includes all ammunition components used in a cannon to fire one round.

b. Fixed ammunition.—In fixed ammunition the cartridge case, which contains the propelling charge and primer, is crimped rigidly to the projectile. Until recently, designs of fixed rounds provided for issue of the round unfuzed, the fuze to be assembled just prior to firing. In current designs the round is issued as a fixed complete round, the fuze being assembled to the round "as issued."

c. Nomenclature.—Standard nomenclature is used herein in all references to specific items of issue.

d. Firing tables.—Current firing tables and trajectory diagrams are given in the list of references (app.).

62. Classification.—Dependent upon the kind of filler, projectiles may be classified according to type as explosive, chemical, or inert. Explosive projectiles comprise high explosive, practice, and shrapnel. High explosive projectiles contain a high explosive bursting charge, whereas shrapnel and practice projectiles contain a relatively small quantity of low explosive filler. The low explosive filler for practice projectiles is intended solely as a spotting charge and for some purposes may be omitted. Chemical projectiles comprise those containing a chemical filler, that is, a chemical agent which produces either a toxic or an irritating physiological effect, a screening smoke, an incendiary action, or a combination of these. Inert projectiles contain no explosive.

63. Identification.—Ammunition, including components, is completely identified by the painting, marking (includes ammunition lot

number), and the accompanying data card. Other essential information such as weight zone and muzzle velocity may be obtained from the marking and data card. (See figs. 65, 66, 67, and 68, and *a*, *b*, and *c* below.)

a. Mark or model.—To identify a particular design a model designation is assigned. This model designation becomes an essential part of the standard nomenclature and is included in the marking on the item. Prior to July 1, 1925, it was the practice to assign mark numbers, the word "Mark" being abbreviated "Mk.," which was followed by a roman numeral, for example, SHELL, HE, Mk. I. The first modification of a model was indicated by the addition of MI, the second by MII, etc. Thus, Mk. IMII would indicate the second modification. The present system of model designation consists of the letter M followed by an arabic numeral. Modifications are indicated by adding the letter A and appropriate arabic numeral. Thus, M9A1 indicates the first modification of an item for which the original model designation was M9.

b. Lot number.—(1) When ammunition is manufactured, an ammunition lot number, which becomes an essential part of the marking, is assigned in accordance with pertinent specifications. This lot number is stamped or marked on every loaded complete round, on all packing containers, and on the accompanying ammunition data card. It is required for all purposes of record, including reports on condition, functioning, and accidents in which ammunition is involved. To provide for the most uniform functioning, all rounds in any one lot of fixed ammunition consist of—

(*a*) Projectiles of one lot number (one type and one weight zone).

(*b*) Fuzes of one lot number.

(*c*) Primers of one lot number.

(*d*) Propellent powder of one lot number.

(2) Therefore to obtain the greatest accuracy in any firing, successive rounds should be from the same ammunition lot, whenever practicable.

c. Data card.—A 5- by 8-inch card, known as an ammunition data card, is packed in each packing box with the ammunition or, in the case of bundle packing, with the round in each fiber container. When necessary assembling instructions are printed on the reverse side of the card.

64. Painting and marking.—*a. Painting.*—All projectiles are painted to prevent rust, and by color to provide a ready identification as to type. The color scheme is as follows:

(1) High explosive projectiles, yellow; marking in black.

(2) Chemical projectiles, gray. One green band painted on a chemical projectile indicates nonpersistent gas. Two green bands indicate persistent gas. One yellow band indicates a smoke projectile. The marking on chemical projectiles is in the same color as the band.

(3) Shrapnel, red; marking in black.

(4) Practice projectiles, blue; marking in white. These may contain only a sand filler with an inert fuze or they may contain a live fuze with a spotting charge of black powder.

(5) Dummy or drill projectiles which contain no explosive, black; marking in white.

b. Marking.—(1) *On projectile.*—The following information is stenciled or stamped on the projectile in all fixed rounds except shrapnel. (On shrapnel, the only marking is that of caliber, type of cannon in which fired, and lot number.)

(*a*) Caliber and type of cannon in which fired.

(*b*) Kind of filler; for example, TNT, CN GAS, etc.

(*c*) Mark or model of projectile.

(*d*) Weight zone marking.

(*e*) Lot number of loaded projectile. Because the lot number of the loaded projectile is ordinarily not required after the complete round has been assembled, it is stenciled below the rotating band, where it is covered by the neck of the cartridge case.

(2) *On cartridge case.*—Changes have been made recently in the marking on cartridge cases. The marking being used on ammunition of new manufacture as well as on currently renovated ammunition is shown compared with the old marking in (*a*) and (*b*) below.

(*a*) On the body of the cartridge case, marking in black unless otherwise indicated.

Old marking	New marking
FLASHLESS when propelling charge is of flashless (FNH) powder.	Omitted.
REDUCED CHARGE between two black bands indicates reduced charge; SUPERCHARGE in red or black indicates supercharge; absence of such markings indicates normal charge.	REDUCED CHARGE between two black bands indicates reduced charge; NORMAL below one black band indicates normal charge; SUPER indicates supercharge.
Initials of powder manufacturer, symbol of powder, and lot number.	Omitted.

Old marking	New marking
Caliber and type of cannon in which fired.	Omitted.
Muzzle velocity in feet per second. On normal charge rounds muzzle velocity is inclosed in a black rectangle.	Omitted.

(*b*) On the base of cartridge case, marking in black unless otherwise indicated.

Ammunition lot number (in older lots, stamped in the metal).	Ammunition lot number and initials of loader.
FLASHLESS when propelling charge is flashless (FNH) powder.	Omitted.
Model of projectile. Absence of such model indicates shrapnel. If chemical, the kind of filler is shown.	Model of projectile.
One diametral stripe indicates normal charge; two diametral stripes at right angles indicate reduced charge; SUPERCHARGE indicates supercharge.	NORMAL below one diametral stripe indicates normal charge; REDUCED and two diametral stripes at right angles indicate reduced charge; SUPER indicates supercharge.
Caliber, type, and model of cannon in which fired (stamped in the metal).	Caliber and model of cartridge case (stamped in the metal).
Cartridge case lot number and initials of cartridge case manufacturer (stamped in the metal).	Cartridge case lot number, initials of cartridge case manufacturer, and year of manufacture (stamped in the metal).

65. Weight zone markings.—Because it is not practicable to manufacture projectiles, except shrapnel, within the narrow weight limits required for the desired accuracy of fire, projectiles are grouped into weight zones so ballistic corrections indicated by firing tables may be applied. The weight zone of each projectile is indicated on it by crosses, one, two, three, or more. A weight zone lighter than one cross is indicated by L. LL indicates a weight zone lighter than L. Two crosses indicate normal weight.

66. Care and preservation.—*a.* Complete rounds and ammunition components are packed to withstand conditions ordinarily encountered in the field. Each complete round is packed in an individual moisture-resistant metal or fiber container and then in a wooden packing box or bundle. Fuzes issued separately are packed in sealed metal-lined boxes. Nevertheless, since explosives are adversely affected by moisture and high temperature, due consideration should be given to the following:

(1) Do not break moisture-resistant seal until ammunition is to be used.

(2) Protect ammunition, particularly fuzes, from high temperatures, including the direct rays of the sun. More uniform firing is obtained if all rounds are at the same temperature.

b. Do not attempt to disassemble any fuze.

c. Do not remove adapter closing plug from unfuzed rounds until fuze is to be assembled. The adapter closing plug is provided to keep the fuze opening free of foreign matter so the fuze may be readily and properly screwed in.

d. Handle fuzes with care. The explosive elements are particularly sensitive to undue shock and high temperature.

e. The complete round should be free of foreign matter, sand, mud, grease, etc., before loading into the gun.

f. Do not remove protection or safety devices from fuzes until just before use.

g. Components of rounds prepared for firing but not fired will be returned to their original packings and appropriately marked. Such components will be used first in subsequent firings so stocks of opened packings may be kept to a minimum.

67. Authorized rounds.—The 75-mm guns M1897, M1897A1, M1897A2, M1897A3, and M1897A4 being chambered alike, fire the same ammunition. Authorized ammunition is listed below. It will be noted that the designation completely identifies the ammunition as to type and model of projectile and fuze, type and kind of propelling charge, and caliber of gun in which the round is fired. To the nomenclature of ammunition issued unfuzed, a suffixed statement such as "adapted for fuze, PD, Mk. III, M35, M46, or M47," indicates the authorized fuzes. For ammunition issued fuzed, a statement in the nomenclature such as "with fuze, PD, M48," indicates the type and model of fuze assembled to it.

AMMUNITION FOR 75-MM FIELD GUNS M1897, M1897A1, M1897A2, M1897A3, AND M1897A4

Nomenclature	Prescribed fuzes		Substitute fuzes	
	Model	Action	Model	Action
Service ammunition				
Shell, fixed, gas, persistent, HS, Mk. II, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46 M47	SQ Del	Mk. III or M35.	SQ.
Shell, fixed, HE, M48, normal charge, with fuze, PD, M48.	M48	SQ–Del		
Shell, fixed, HE, M48, normal charge, with fuze, PD, M54.	M54	Time–SQ		
Shell, fixed, HE, M48, reduced charge, with fuze, PD, M48.	M48	SQ–Del		
Shell, fixed, HE, M48, reduced charge, with fuze, PD, M54.	M54	Time–SQ		
Shell, fixed, HE, M48, supercharge, with fuze, PD, M48.	M48	SQ–Del		
Shell, fixed, HE, M48, supercharge, with fuze, PD, M54.	M54	Time–SQ		
Shell, fixed, HE, Mk. I, flashless, reduced charge, unfuzed (adapted for fuze, PD, M46 or M47).	M46 M47	SQ Del		
Shell, fixed, HE, Mk. I, flashless, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46 M47	SQ Del	Mk. III or M35.	SQ.
Shell, fixed, HE, Mk. I, reduced charge, unfuzed (adapted for fuze, PD, M46 or M47).	M46 M47	SQ Del		
Shell, fixed, HE, Mk. I, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46 M47	SQ Del	Mk. III or M35.	SQ.
Shell, fixed, smoke, FM, Mk. II, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46 M47	SQ Del	Mk. III or M35.	SQ.
Shell, fixed, smoke, FS, Mk. II, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46 M47	SQ Del	Mk. III or M35.	SQ.

AMMUNITION FOR 75-MM FIELD GUNS M1897, M1897A1, M1897A2, M1897A3, AND M1897A4—Continued

Nomenclature	Prescribed fuzes		Substitute fuzes	
	Model	Action	Model	Action
Service ammunition—Con.				
Shell, fixed, smoke, phosphorus, WP, Mk. II, unfuzed (adapted for fuze, PD, Mk. III, M35, M46, or M47).	M46	SQ	Mk. III or M35.	SQ.
Shot, fixed, AP, M61, w/tracer	None			
Shot, fixed, SAP, M72, w/tracer.	None			
Shrapnel, fixed, Mk. I	M1907M	21-second		
Shrapnel, fixed, Mk. I, flashless.	M1907M	21-second		
Target practice ammunition				
Shell, fixed, practice, sand-loaded, Mk. I (with inert fuze, PD, Mk. IV).	Mk. IV, inert.			
Blank ammunition				
Ammunition, blank (double-pellet charge), 75-mm guns M1897, M1916, M1917, and 75-mm pack howitzer, M1 and M1A1.	None			
Ammunition, blank (single-pellet charge), 75-mm guns M1897, M1916, M1917, and 75-mm pack howitzer, M1 and M1A1.	None			
Drill ammunition				
Cartridge, drill, M7, 75-mm guns, M1897, M1916, M1917.	M1907M, inert.			
	M46, inert.[1]		Mk. III, inert.[1]	
	M47, inert.[1]			
Subcaliber ammunition				
Shell, fixed, practice, Mk. II, with fuze, practice, M38, 37-mm gun, M1916.	M38			

[1] Requires adapter, 72-3-66M.
SQ—Superquick.
Del—Delay.
PD—Point detonating.

68. Fuzes.—*a. General.*—A fuze is a mechanical device used with a projectile to explode it at the time and under the circumstance desired.

NOTE.—No attempt will be made to disassemble any fuze. The only authorized operation will be that of screwing the fuze into the projectile, or out if not fired (par. 66*g*).

b. Types.—(1) Fuzes may be classified into two principal types: those which function by time action a certain number of seconds after firing, and those which function as the result of impact of the fuze or the projectile with a resistant object.

(2) Further subdivision of the impact types depends upon quickness of action, classifications being superquick, nondelay, short delay, and long delay.

(3) Dependent upon manner of arming, certain fuzes are considered to be boresafe as distinct from those which are not boresafe. A boresafe fuze is one in which the explosive train is so interrupted that prior to firing, and subsequent to firing, while the projectile is still in the bore of the cannon, premature functioning action of the bursting charge is prevented should any of the more sensitive elements, primer and/or detonator, malfunction.

c. Boresafe and nonboresafe.—Fuzes classified as boresafe and nonboresafe are—

Nonboresafe	Boresafe
Point detonating:	Point detonating:
Mk. III superquick:	
Without interrupter	M48.[1]
With interrupter	M54.[1]
Mk. IIIA superquick:	
Without interrupter	
With interrupter	
M35	
M46	
M47	
Combination, 21-second, M1907M [1]	

[1] Assembled to fixed round. Not issued separately for use in the field.

NOTE.—Fuzes, PD, M35, M46, and M47 do no come within the definition of boresafe fuzes as defined in *b*(3) above, but may be fired under the same conditions. Mk. III and Mk. IIIA, superquick, with and without interrupter, are not to be used for target practice.

69. Point detonating fuzes.—*a. Mk. III superquick.*—(1) *Without interrupter.*—Except that this fuze has no interrupter, it is the

same as the Mk. III superquick with interrupter. With this exception the description in (2) below applies.

(2) *With interrupter.*—(*a*) *Description.*—This fuze (fig. 70) is of the direct action type intended to detonate with the least possible penetration of the projectile. Subject to the provisions of AR 750–10, authorized use is shown in paragraph 67. It should not be used in ammunition with a reduced charge since this lower velocity causes the projectile to be unstable in flight.

(*b*) *Preparation for firing.*—To assemble the fuze to the round—

1. Remove adapter closing plug from the projectile.

2. Visually inspect fuze cavity and threads. They should be free of any foreign matter which would interfere with proper assembly of the fuze.

3. Screw fuze into the adapter by hand. (It is essential that the felt washer provided with the fuze be under detonator socket flange when fuze is screwed into adapter.) Tighten with fuze wrench. Use only fuzes on which the original waterproof seal of lead foil cap is unbroken.

4. Before loading the round into the gun, remove waterproof cap by pulling on the exposed loose end of tape. Examine visually the spiral (brass ribbon) where it is coiled around the fuze and safety pin to see that they are in good condition. When either is damaged or missing, remove the fuze and replace by a serviceable fuze. Complete round is now ready for firing. Dispose of the unserviceable fuze.

b. Mk. IIIA superquick.—(1) *Without interrupter.*—This fuze may be distinguished from the Mk. III superquick without interrupter by the "A" in the model designation stamped on the body of the fuze. Otherwise, the only difference between these two fuzes is the arrangement of the upper detonator.

(2) *With interrupter.*—This fuze may be distinguished from the Mk. III superquick with interrupter by the "A" in the model designation stamped on the body of the fuze. Otherwise, the only difference between these two fuzes is in the arrangement of the upper detonator.

c. M35.—(1) *Description.*—This fuze (fig. 71) is a modified Mk. III superquick type. Compared with the Mk. III type, it is somewhat shorter, and a sleeve has been added to hold the spiral (brass ribbon) in position. The sleeve is held in place by a pin which is sheared by setback in firing, freeing the spiral. For safety in transportation a spring clip, designated "sleeve support," is used. This fuze, like

the Mk. III type, is unsuitable for use in reduced charge rounds due to lack of stability of the projectile.

(2) *Preparation for firing.*—To assemble the fuze to the round—

(*a*) Remove adapter closing plug from projectile.

(*b*) Visually inspect fuze cavity and threads. They should be free of foreign matter which would interfere with proper assembly of the fuze.

(*c*) Screw fuze into adapter by hand. (It is essential that the felt washer provided with the fuze be under detonator socket flange when fuze is screwed into adapter.) Tighten with fuze wrench.

(*d*) With a pull on the ring, remove sleeve support. The round is now ready for firing.

d. M46.—(1) *Description.*—This fuze, a superquick type (fig. 72), is a further modification of the Mk. III type. The firing mechanism has been modified to eliminate the spiral and split rings. A lighter firing pin is supported on a brass cup sufficiently strong to resist the setback produced by acceleration in the gun, but which is crushed when the firing pin is driven into the primer on impact. This fuze is suitable for use with either normal or reduced charge rounds.

(2) *Preparation for firing.*—To fuze the round—

(*a*) Remove adapter closing plug from projectile.

(*b*) Visually inspect fuze cavity and threads. They should be free of foreign matter which would interfere with proper assembly of the fuze.

(*c*) Screw fuze into adapter by hand. (It is essential that the felt washer provided with the fuze be under detonator socket flange when fuze is screwed into adapter.) Tighten with fuze wrench. The complete round is now ready for firing.

e. M47.—(1) *Description.*—This fuze, a delay type (fig. 73), is identical ballistically with the point detonating fuze M46. It can be distinguished from the latter, however, by the marking and the black head; the M46 fuze has a white head. To provide for delay action, a delay pellet, about 0.05 second, is incorporated in the explosive train between upper and lower detonators.

(2) *Preparation for firing.*—To fuze the round—

(*a*) Remove adapter closing plug from projectile.

(*b*) Visually inspect fuze cavity and threads. They should be free of foreign matter which would interfere with proper assembly of the fuze.

(*c*) Screw fuze into adapter by hand. (It is essential that the felt washer provided with the fuze be under detonator socket flange when fuze is screwed into adapter.) Tighten with fuze wrench. The round is now ready for firing.

f. M48.—(1) *Description.*—This fuze (fig. 74) is a combination superquick and short delay type. It will always be issued assembled to shell. The fuze contains two actions, superquick and delay. On the side of the fuze near the base is a slotted "setting sleeve" and two registration lines, one parallel to axis of fuze, the other at right angles. The line parallel to the axis is marked SQ, the other DELAY. To set the fuze, turn the setting sleeve so the slot is alined with either SQ or DELAY. The setting may be made or changed at will with a screw driver or similar instrument any time before firing, even in the dark by noting the position of the slot, parallel to the fuze axis for SQ, at right angles for DELAY. It should be noted that in this fuze, even though set superquick, the delay action will operate if the superquick action fails to function.

(2) *Preparation for firing.*—Prior to firing it is only necessary to set the fuze and this only when delay action is required. When shipped, the fuze is set superquick.

g. M54.—(1) *Description.*—This standard fuze (fig. 75) is a combination time and superquick type. These fuzes will always be issued assembled to shell. A safety pin extends through the fuze to secure the time plunger during shipment. The fuze contains two actions, time and superquick. The superquick action is always operative and will function on impact, unless prior functioning has been caused by the time action. Therefore, to set the fuze for superquick action, it is required that the time action be set either at safe (S) or for a time longer than the expected time of flight. The time train ring, graduated for 25 seconds, is similar to that of other powder time train fuzes. To prevent extremely short time action, an internal safety feature is incorporated in the time train. This prevents the time action from functioning should the fuze be set for less than 0.4 seconds. Therefore when setting for time action, the setting should always be greater than this minimum of 0.4 seconds. The fuze is set for time by a fuze setter.

(2) *Preparation for firing.*—Prior to firing, the safety pin must be withdrawn from the fuze. If superquick action is required, the graduated time ring is set safe (S) or for a time greater than the expected time of flight.

NOTE.—The fuze, as shipped, is set safe. If time action is required, the graduated time train ring is set for the required time of burning by a fuze setter.

70. Combination fuze, 21-second, M1907M.—*a. Description.*—This fuze (fig. 76) is a combination percussion time type, designed for use with shrapnel. These fuzes will always be issued assembled to shell. The fuze contains two actions, percussion and time.

The percussion action is always operative and will function on impact unless prior functioning has been caused by the time action. When percussion action is wanted, it is only necessary to set the graduated time train ring at safe (S) or for a time longer than the expected time of flight. The time train ring is similar to that of other powder time train fuzes and is graduated for 21.2 seconds. The fuze is set for time by a fuze setter. In the particular case of zero setting, canister effect is obtained, that is, the fuze functions just beyond the muzzle of the cannon and the shrapnel balls are projected from the shrapnel case somewhat similar to shot from a shotgun. Because the powder time train is adversely affected by moisture, make every effort to keep the fuze dry.

b. Preparation for firing.—The waterproof fuze cover must first be removed. If percussion action is wanted, the graduated time is set safe (S) or for a time greater than the expected time of flight.

NOTE.—The fuze as shipped is set safe. If time action is required, the graduated time train ring is set for the required time of burning by a fuze setter.

71. Packing.—*a.* Fixed rounds of 75-mm gun ammunition are packed in individual metal or fiber containers, and these in wooden boxes containing four rounds, or in special bundle packings of three rounds. While the weights of the individual rounds vary somewhat, depending upon type and model, the following data are considered representative for estimating weight and volume requirements:

	Weight (pounds)	*Volume (cubic feet)*
Complete round without packing material	18	
3 rounds in bundle packing	69	1.0
4 rounds in wooden packing box	100	1.7

The over-all dimensions of the packings are—

3-round bundle (inches), 27⅛ by 8.10 by 7.57.
4-round box (inches, 30¾ by 9 11/16 by 9 11/16.

Bundles for oversea shipment are crated.

b. Fuzes.—Similar representative data for fuzes are—

Approximate dimensions of wooden box (inches), 18 by 9 by 8.
Approximate volume (cubic feet), 0.80.
Approximate weight of box and 50 fuzes (pounds), 53.

72. Subcaliber.—*a. General.*—The shell, fixed, practice, Mk. II, with fuze, practice, M38, 37-mm gun M1916, is authorized for use in the 37-mm gun M1916 when used for subcaliber purposes with the 75-mm gun M1897 or modification. This ammunition is issued in the

form of fixed complete rounds. The projectile is fitted with a base fuze and contains a low explosive filler of black powder. When used for target practice the low explosive filler serves as a spotting charge. The complete round is shown in figure 77 and may be identified by the indicated marking.

b. Packing.—Two methods of packing are standard: one, a wooden box of 60 rounds with metal liner for oversea shipments; the other a wooden box of 40 rounds without metal liner for domestic shipments. Data for these packings are:

	Weight (pounds)	*Volume (cubic feet)*
Complete round without packing material	1.62	
Oversea shipments:		
Box with metal liner (60 rounds)	128	1.99
Over-all dimensions of box (inches); $23\frac{5}{16}$ by $13\frac{5}{16}$ by $11\frac{1}{16}$.		
Domestic shipments:		
Box without metal liner (40 rounds)	90.2	1.40
Over-all dimensions of box (inches), $18\frac{1}{8}$ by $11\frac{7}{8}$ by $10\frac{29}{32}$.		

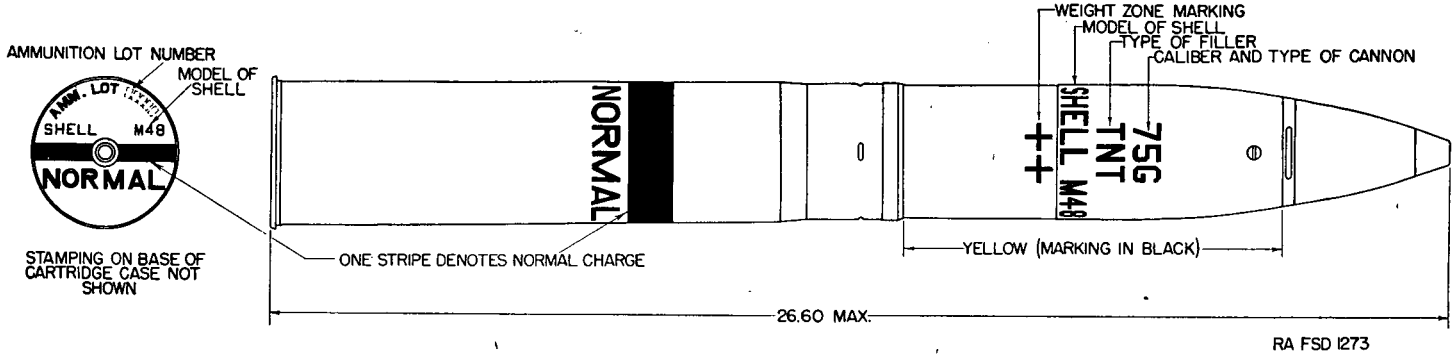


FIGURE 65.—Shell, fixed, HE, M48, with point detonating fuze M48, 75-mm gun, as fired.

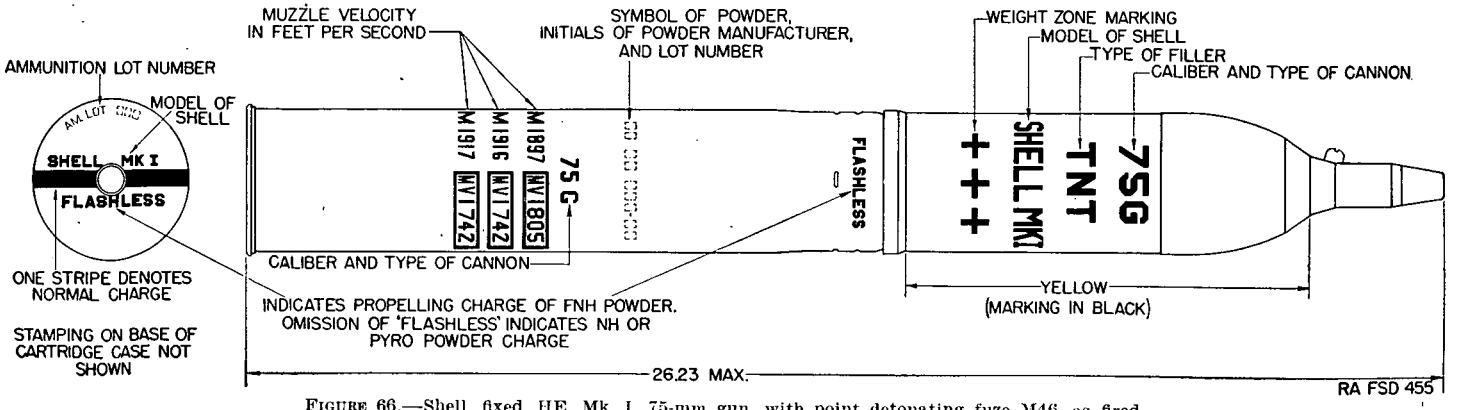
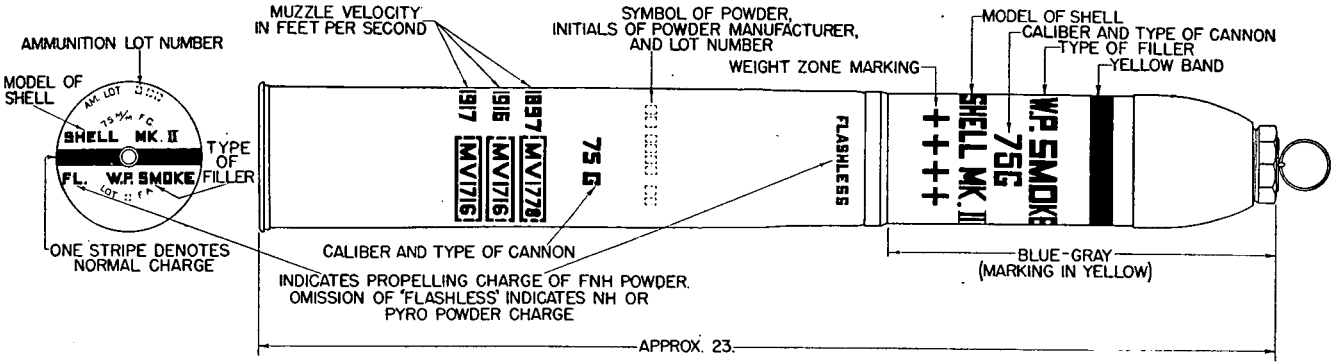
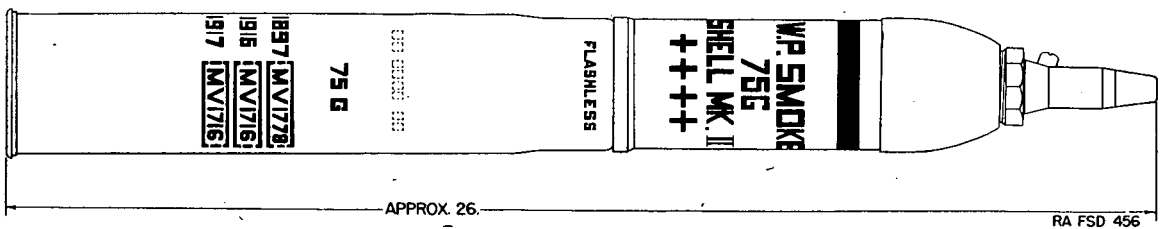


FIGURE 66.—Shell, fixed, HE, Mk. I, 75-mm gun, with point detonating fuze M46, as fired.

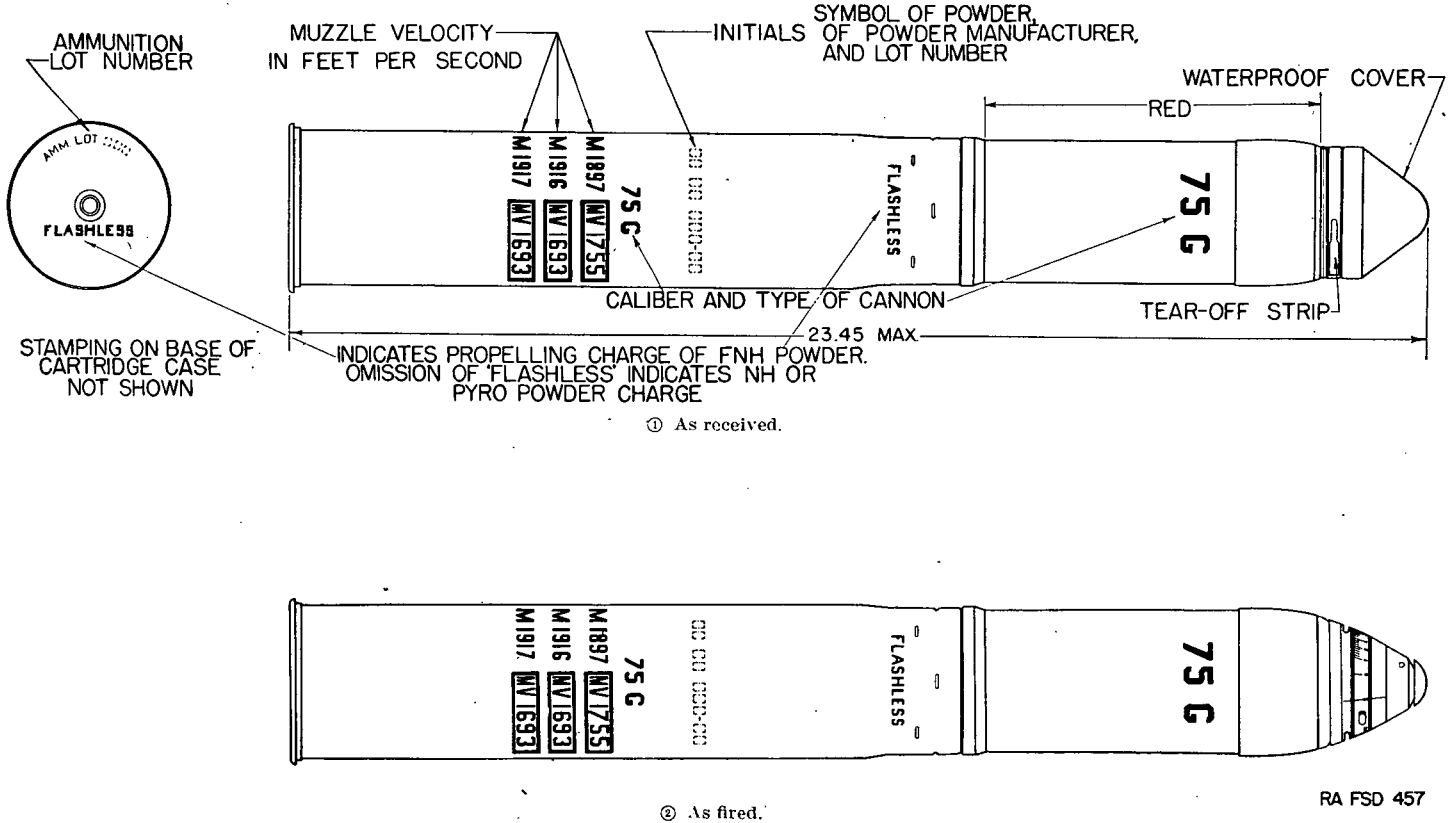


① Unfuzed, as received.



② With point detonating fuze M46, as fired.

FIGURE 67.—Shell, fixed, smoke, phosphorus, WP, Mk. II, 75-mm gun.



① As received.

② As fired.

FIGURE 68.—Shrapnel, fixed, Mk. I, flashless. 75-mm gun.

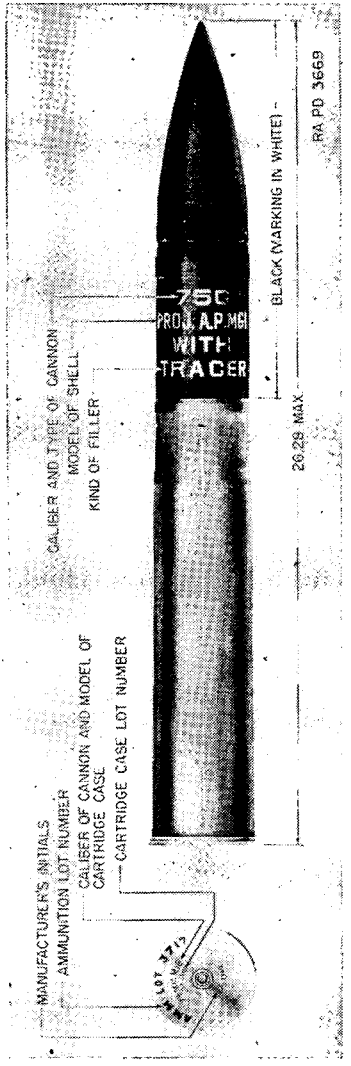


FIGURE 60.—Shell, fixed, AP, M61, supercharge, w/tracer, 75-mm gun.

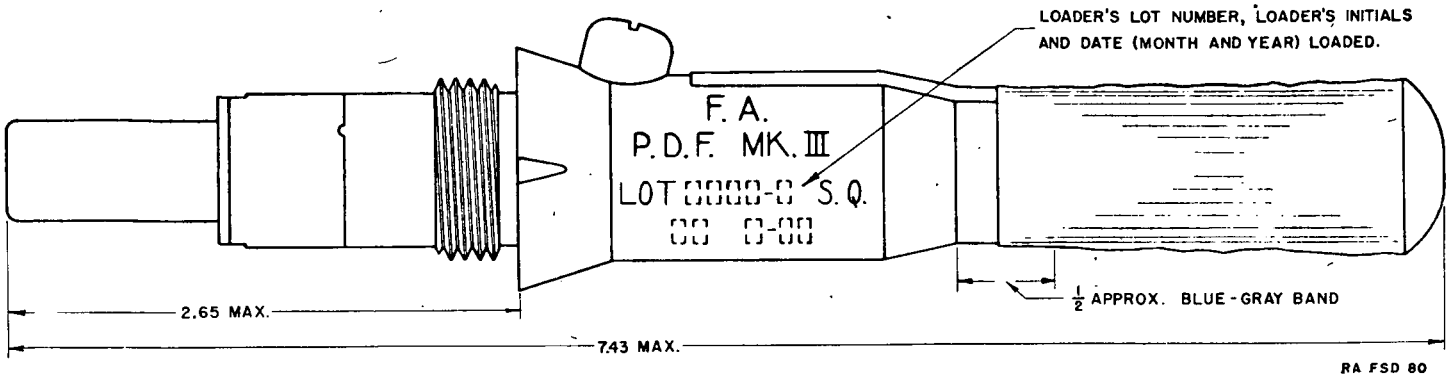


FIGURE 70.—Fuze, point detonating, Mk. III, superquick, with interrupter.

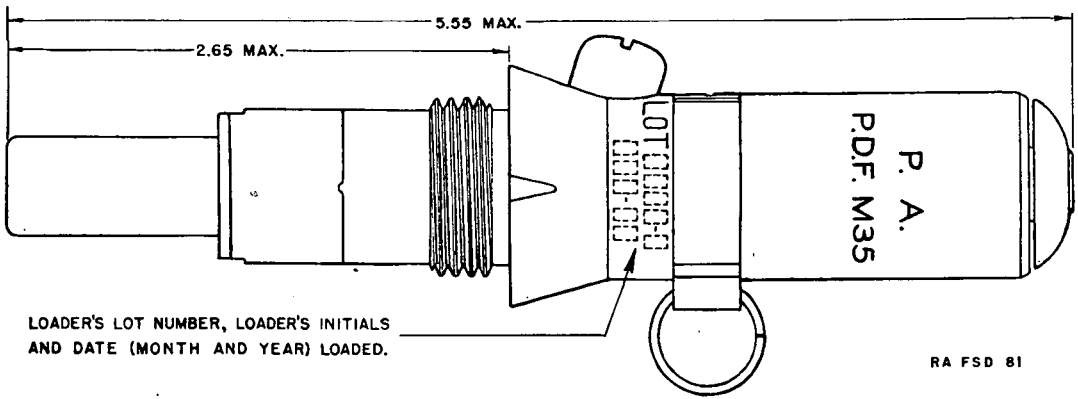


FIGURE 71.—Fuze, point detonating, M35.

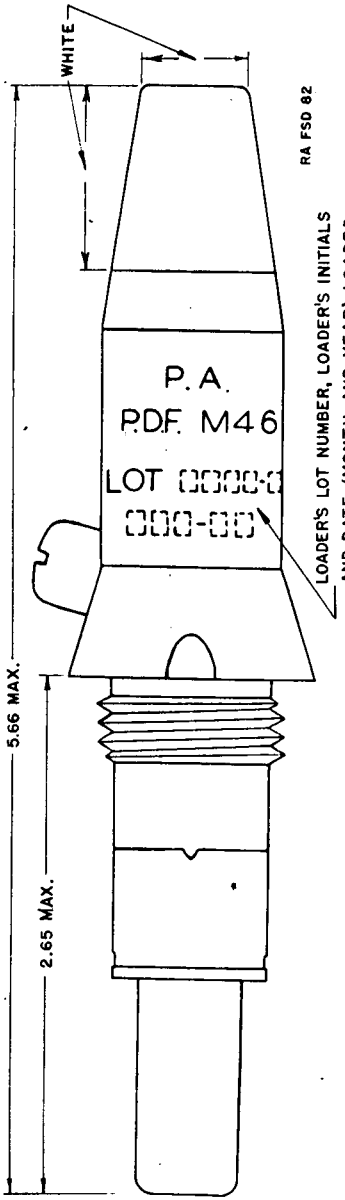


FIGURE 72.—Fuze, point detonating, M46.

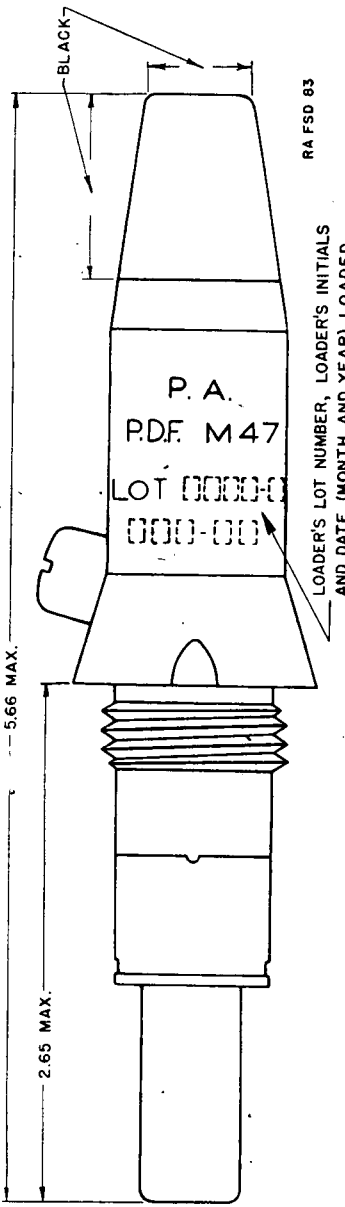


FIGURE 73.—Fuze, point detonating, M47.

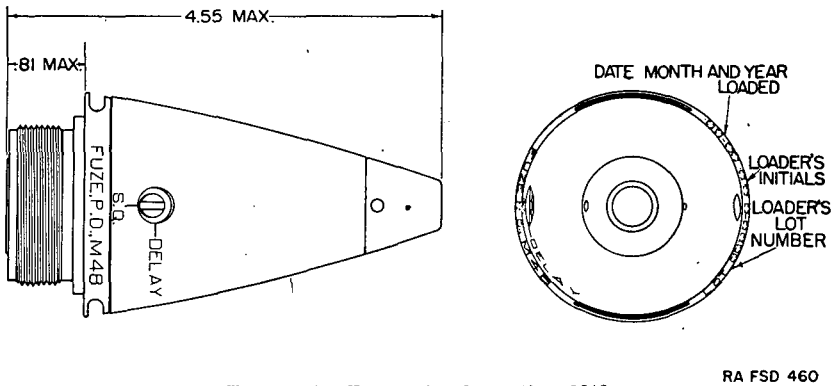


FIGURE 74.—Fuze, point detonating, M48.

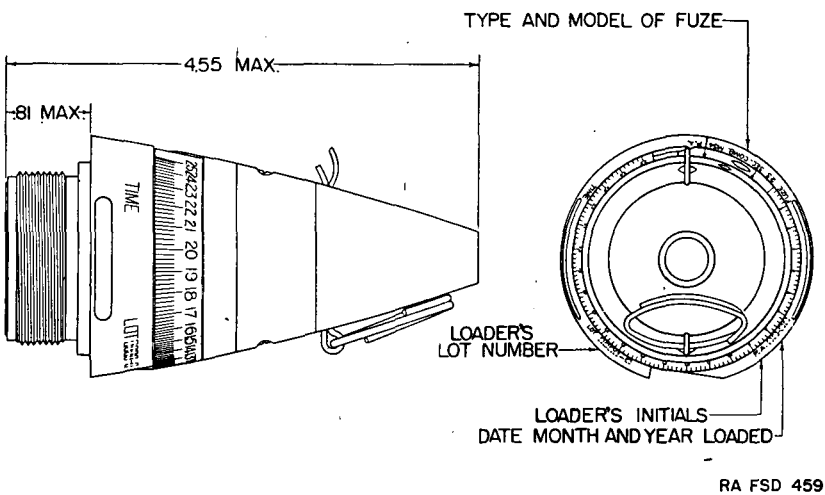


FIGURE 75.—Fuze, point detonating, M54.

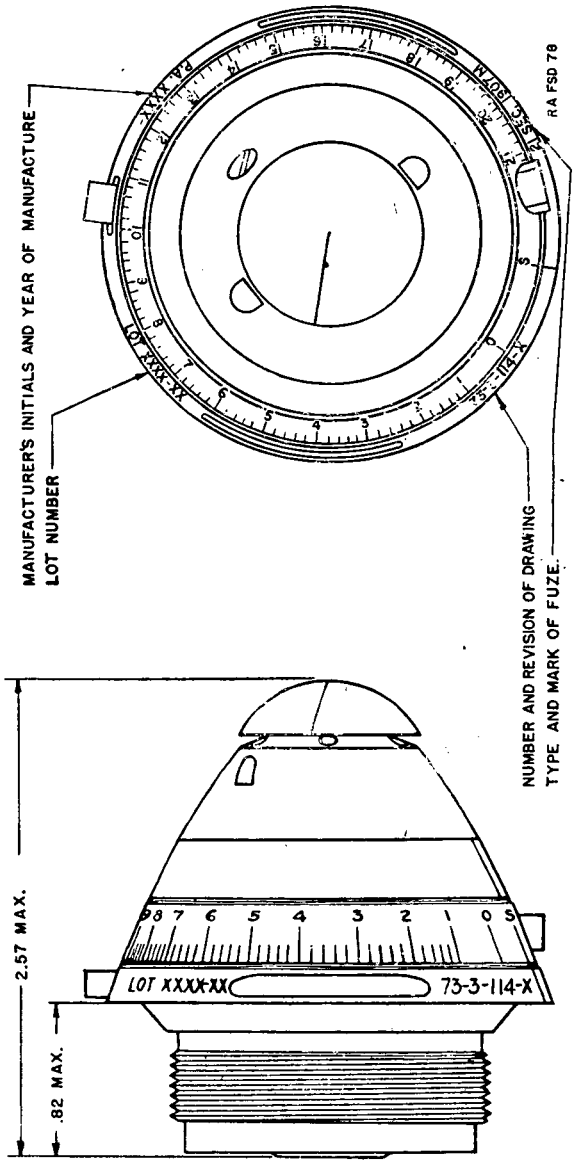


FIGURE 76.—Fuze, combination, 21-second, M1907M.

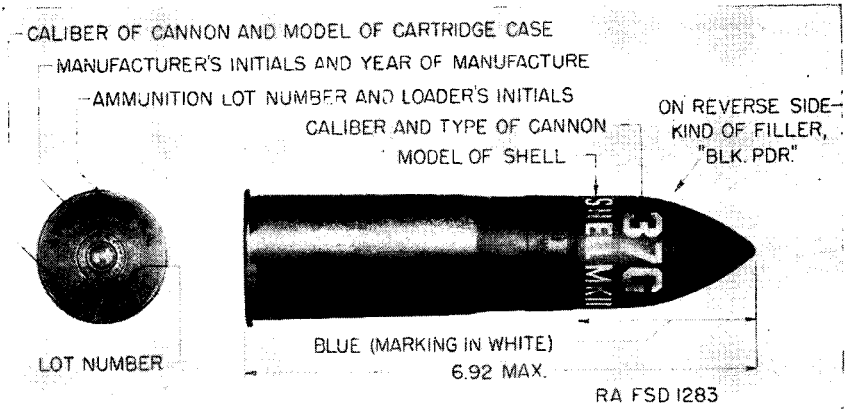


FIGURE 77.—Shell, fixed, practice, Mk. II, with fuze, practice, M38, 37-mm gun, M1916.

CHAPTER 5

CAISSON, LIMBERS, AND REELS

		Paragraphs
SECTION I.	Data	73–77
II.	Description of parts common to several vehicles	78–83
III.	Description of vehicles	84–89
IV.	Operation	90–92
V.	Disassembly and assembly	93–98
VI.	Care and preservation	99–107

SECTION I

DATA

	Paragraph
75-mm gun carriage limber M1918 and 75-mm gun caisson limber M1918	73
75-mm gun caisson M1918	74
Battery reel M1917A2	75
Artillery reel M1909M1	76
Artillery cart M1918A1	77

73. 75-mm gun carriage limber M1918 and 75-mm gun caisson limber M1918.

Vehicle	Carriage limber	Caisson limber
Weight without ammunition or equipment—pounds	1,038	1,071
Weight of equipment (oilcans filled)—pounds	108	108
Maximum capacity of ammunition chest—rounds	21	39
Normal load of ammunition chest [1]—rounds	18	36
Number of oil cans	3	3
Wheel base:		
Carriage limber limbered to 75-mm gun carriage M1897M1A1—inches	131.65	
Caisson limber with caisson—inches		117.25
Road clearance under vehicle—inches	24	24

[1] Weight of one round of shell, unfuzed (approx.)—pounds 16
Weight of one round of shrapnel, fuzed (approx.)—do 20

74. 75-mm gun caisson M1918.

Weight without ammunition or equipment—pounds	1,425
Weight of equipment—do	62
Weight of one round of shrapnel, fuzed (about)—do	20
Weight of one round of shell, unfuzed (about)—do	16

Maximum capacity of ammunition chest	rounds	70
Capacity of one fuze chest	fuzes (PD)	36
Capacity of fuze chest receptacle	chests	6
Road clearance under caisson	inches	21

75. Battery reel M1917A2.

Weight of battery reel empty	pounds	1,385
Weight of accessories carried	do	62
Weight of communication equipment carried (includes 1.7 miles of wire, twisted pair)	do	331.5
Weight of fire-control equipment carried (about)	do	112
Weight of topographical equipment carried (about)	do	22
Weight of battery reel, completely equipped and loaded (about)	do	2,252
Road clearance under reel	inches	19
Number of revolutions of drum to one of wheel		4.62

76. Artillery reel M1909MI.

Weight of reel without load	pounds	1,402
Weight of reel completely equipped and loaded	do	1,855
Length of wire carried	miles	4
Road clearance (about)	inches	19

77. Artillery cart M1918A1.

Weight of cart without load	pounds	1,499
Weight of cart completely equipped and loaded	do	2,018
Road clearance (about)	inches	26

SECTION II

DESCRIPTION OF PARTS COMMON TO SEVERAL VEHICLES

	Paragraph
Wheels	78
Poles and pole pins	79
Doubletrees, singletrees, and neck yokes	80
Lunettes and pintles	81
Padlocks, bolt snaps, and chains	82
Name plates	83

78. Wheels.—*a.* All vehicles mentioned herein are equipped with standard 56-inch diameter, 3-inch steel-tired wheels.

(1) This wheel is held together by eight carriage bolts which draw the hub box and the hub ring together, clamping the spokes (see fig. 78).

(2) The hub cap assembly screws on the hub box and is held in place by the hub latch plunger which engages in holes in the hub

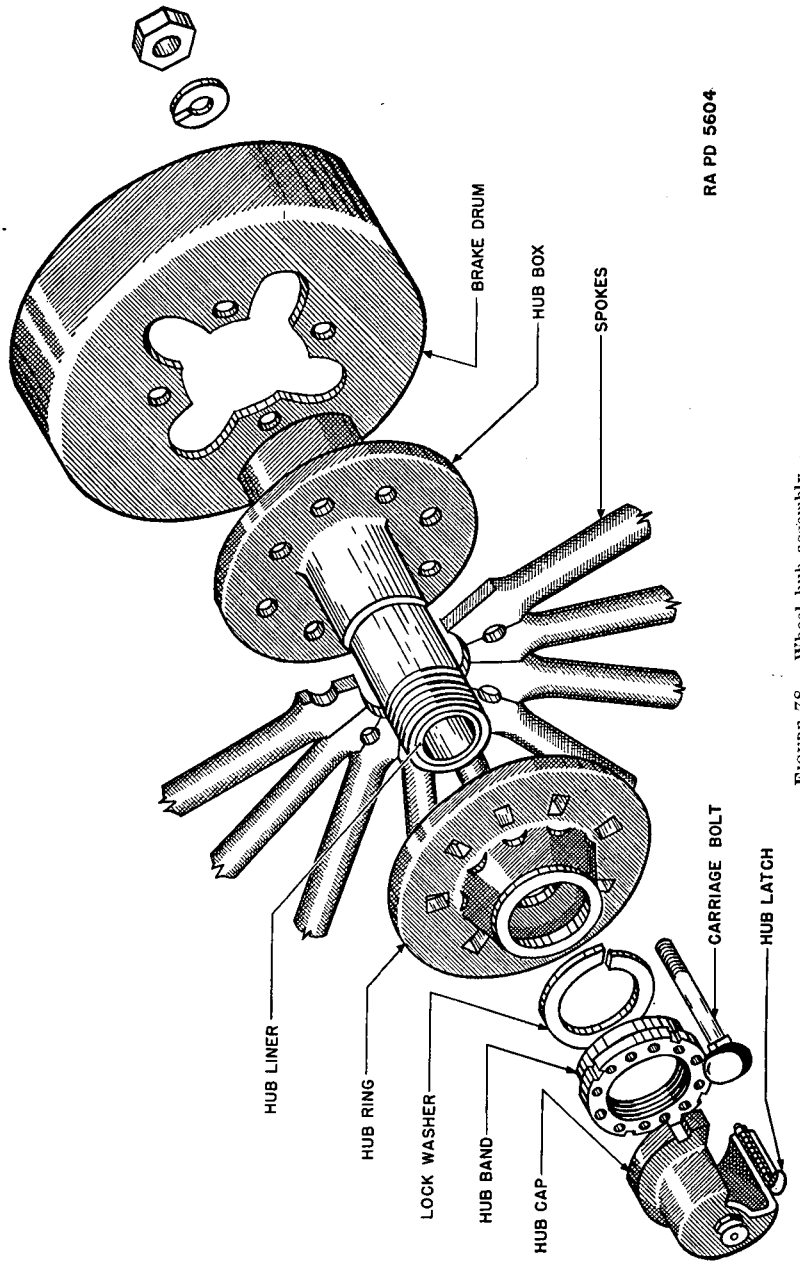


FIGURE 78.—Wheel hub assembly.

band. The cap is fitted with a wheel oil valve which projects into the bore of the axle arm, affording lubrication without removal of the wheel. The rim of the wheel consists of four wooden quarter-arcs of a circle called fellies and a steel tire shrunk on and bolted to the fellies.

(3) In older models, the felly sections are alined with joint clamps and steel dowels (fig. 81). In the present wheel, the joints are embraced by spoke shoes (fig. 88). At the felly end, the spokes bear against steel plates in the spoke shoes.

b. When a brake drum, driving ring, or driving gear is attached to the wheel hub, the eight regular hub-box carriage bolts are replaced by longer bolts.

c. The wheel fastenings for retaining the wheel on the axles are yokes which fit in slots in the outer ends of the axle arms. They are held by small contained spring-plungers and are inclosed by the hub caps of the wheels.

79. Poles and pole pins.—The poles, formerly made of wood, are now tapered steel tubes, strengthened by a reinforce at the socket end and by a neck-yoke chafing plate near the front. The front end is closed by a plug, riveted in place. Just forward of the neck-yoke stop, the neck-yoke counterstop swings downward in a slot cut in the underside of the pole body, and is held in the out position by the counterstop spring. This allows passage of the ring of the neck yoke when it is being placed on the pole, but resists its disengagement until the counterstop is raised by compressing it with the hand. The function of the pole is to guide the vehicle and serves as the means of checking the speed. The pole pin passes through the pole and socket, maintaining the pole in its seat and keeping it from turning. Neither the tractive nor holdback forces are taken by the pole pin. The tractive force is through the doubletree and doubletree pin, and the holdback force is taken at the butt end of the pole.

80. Doubletrees, singletrees, and neck yokes.—*a. Doubletrees.*—The tractive force of the horses is transmitted to the limber frame through the doubletree and doubletree bolt. The doubletree is a U-sectioned beam, stiffened by a reinforce piece and a nipple separator in the middle, and by the separators of the rivets which hold the parts together. The doubletree ropes, which limit the swinging movement of the doubletree, are hooked on to the rear hooks, while the singletrees are hooked on to the front hooks. Generally the upper end of the doubletree bolt is braced back to the framework by a metal strap.

b. Singletrees.—The trace chains of harness are attached to the singletrees for towing the vehicles. The singletree body is a U-sectioned beam with an eye, riveted at the center, which engages the front hook of the double hook on the doubletree. Swinging hooks at each end engage the trace chains of the harness. To engage a trace chain link to a singletree hook, it is necessary to swing the hook to the back side of the singletree to secure the necessary clearance. This prevents accidental unhitching of the trace.

c. Neck yokes.—The center ring of the neck yoke engages the pole. The rings at the ends of the yoke are for the neck yoke straps of the harness. Disengagement of the neck yoke from the pole is prevented

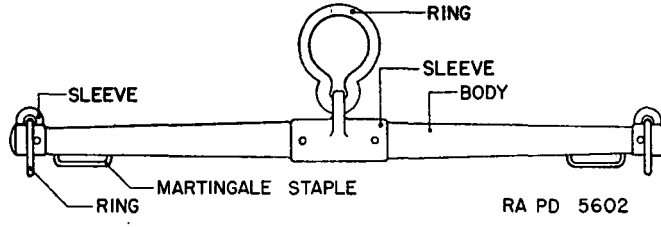


FIGURE 79.—Neck yoke.

by the neck-yoke counterstop of the pole. Since neck yokes and singletrees are detachable, their presence should be noted at every transfer of a vehicle to another organization. They are considered as parts of the vehicle.

81. Lunettes and pintles.—*a. Lunettes.*—The ring on the front of a vehicle (see figs. 85 and 88) by which it is attached to the prime mover or another vehicle is called the lunette. The hook of the limber which couples with the lunette is called the pintle. The pintle is free to rotate.

b. Pintles (fig. 80).—The lunette is retained on the pintle hook by a pintle latch which pivots on a pin in the end of the pintle horn, and is held open or closed by the pintle latch spring. The latch must be closed by hand.

82. Padlocks, bolt snaps, and chains.—*a.* Padlocks furnished for each separate vehicle, other than those having ammunition chests, are alike and are supplied with two keys each. Each padlock and key is stamped with a serial number.

b. Limber and caisson ammunition chests are furnished with a padlock marked "Ammunition" which is supplied with one key only. All ammunition keys are interchangeable.

c. Padlocks are chained to the vehicle to prevent their loss.

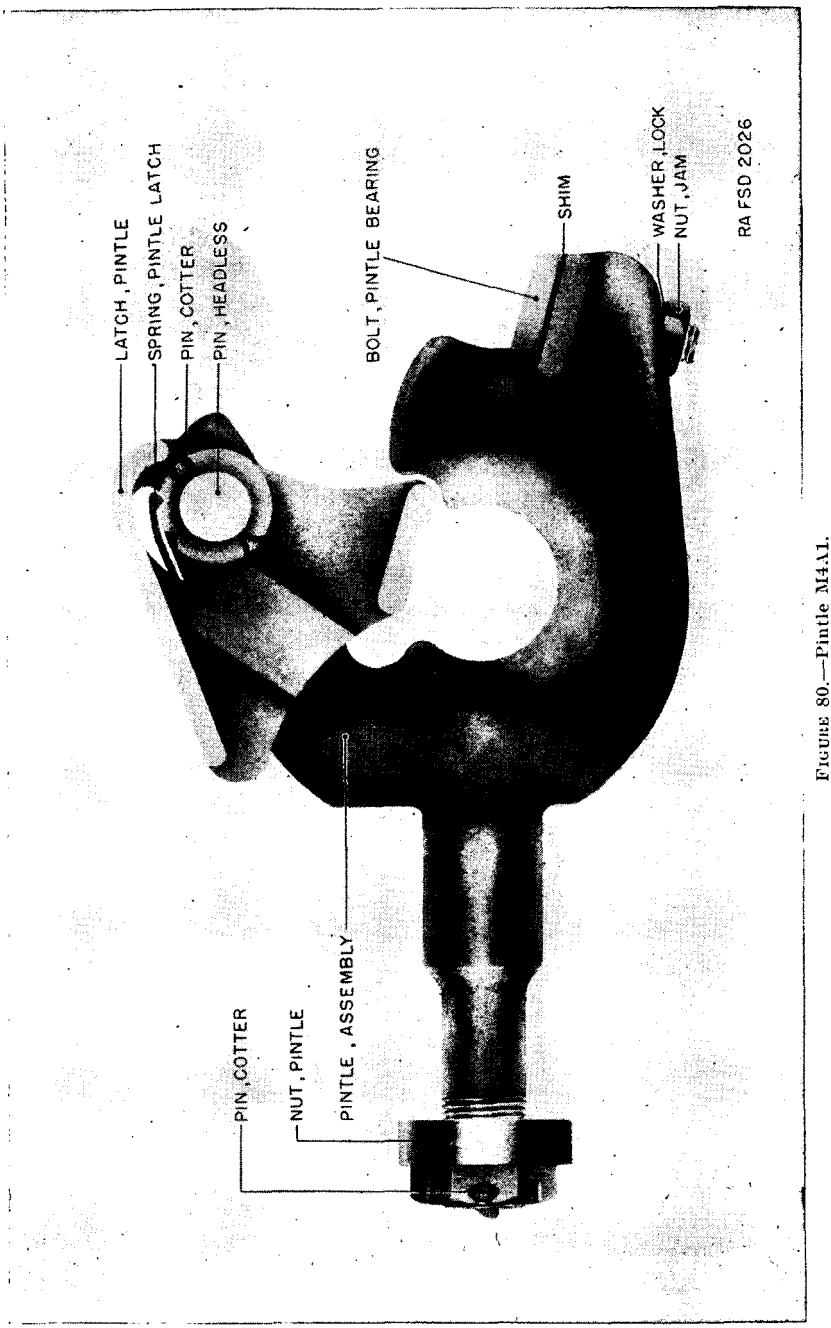


FIGURE 80.—Pintle M4A1.

d. For temporary security and to avoid the trouble of opening a padlock, bolt snaps are commonly provided, especially for doors not fitted with shot bolts, or doors with more than one hasp and staple.

83. Name plates.—A name plate giving the name, number, and model of the vehicle, name of manufacturer, year of completion, and initials of the inspector is attached to each vehicle. All reports and correspondence concerning a particular vehicle must always refer to it by the name, model, and serial number given on the name plate. Location of the name plates on the various vehicles will be found in the description of the particular vehicles.

SECTION III

DESCRIPTION OF VEHICLES

	Paragraph
75-mm gun carriage and gun caisson limbers M1918	84
75-mm gun caisson M1918	85
Hand reel M1917	86
Battery reel M1917A2	87
Artillery reel M1909MI	88
Artillery cart M1918A1	89

84. 75-mm gun carriage and gun caisson limbers M1918.—*a.* The caisson limber (figs. 81–83) and the carriage limber are substantially the same, except for the ammunition chest, which is larger on the caisson limber.

b. With the exception of the spokes and fellies of the wheels, the limber is metal throughout. The principal parts are the wheels, axle, frame, ammunition chest, pole, doubletree, singletrees, and neck yoke.

c. Wheels, wheel fastenings, dust guards, pole, pole pin, doubletree, singletrees, neck yoke, pintle, pintle latch, padlocks, and bolt snaps are described in section II.

d. The frame consists of a middle and two side rails. The middle rail is in the form of a split cylinder, one half passing below and the other half above the axle. The two halves are united in front to form a pole socket and in the rear to form a seat for the pintle bearing guide. Holes in the front end of the middle rail sections form a seat for the pole pin.

e. The side rails are of channel shape, fitting down over the axle brackets and riveted to them. The rear ends project slightly behind the chest to form steps for use of the gunners in mounting. The front ends are bent upward to support the foot rest. The chest is riveted to and supported by the middle portions, which form a part of the bottom of the chest.

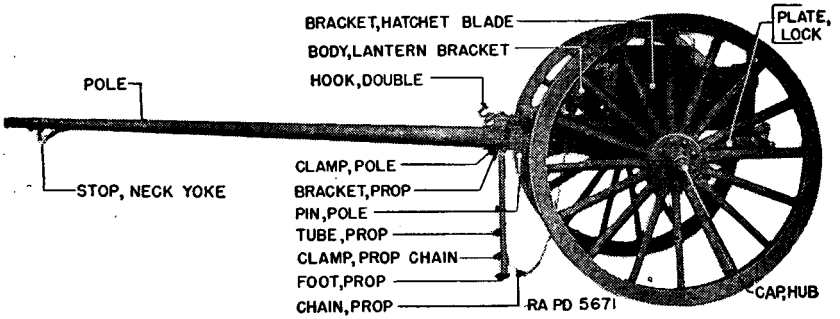


FIGURE 81.—75-mm gun caisson limber M1918, left side.

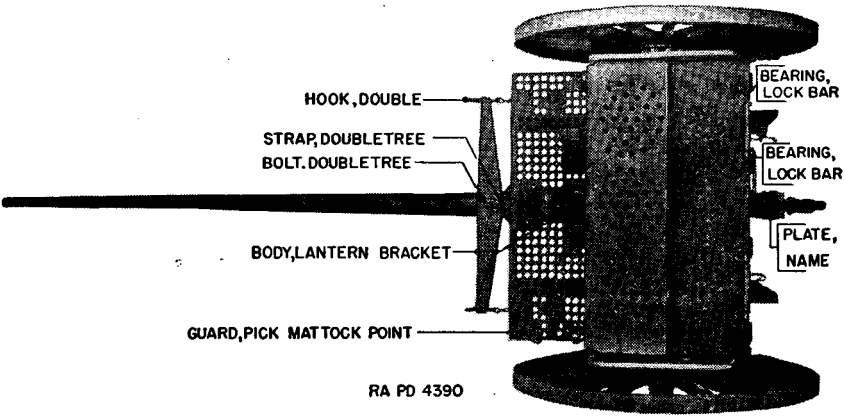


FIGURE 82.—75-mm gun caisson limber M1918, top.

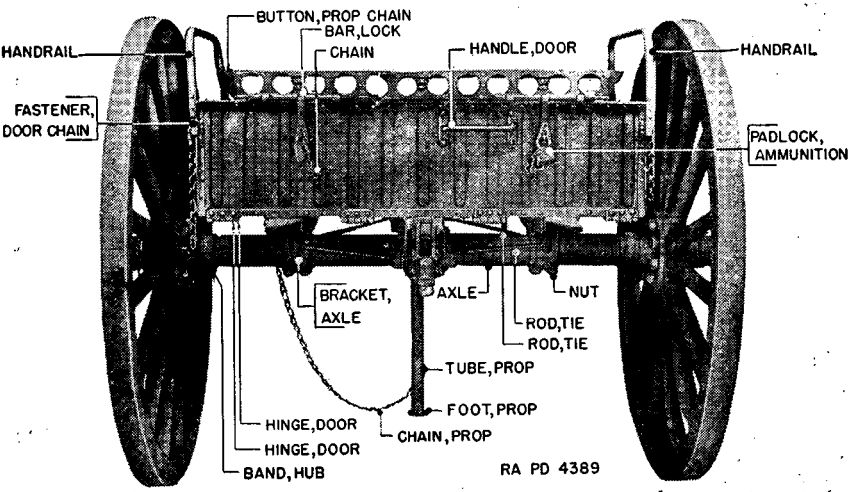


FIGURE 83.—75-mm gun caisson limber M1918, rear.

f. The two axle brackets (fig. 83) are clamped about the axle near the axle arms with two bolts each. Tie-rods pinned to lugs on the axle brackets are attached to the middle rail, in front and rear of the axle, bracing the pole assembly and pintle seats rigidly with the axle.

g. The pole clamp on the front end of the middle rail consists of a collar, split on one side and provided with a clamping bolt for drawing the two halves of the middle rail firmly about the pole. The doubletree seats on top of the pole clamp. The doubletree bolt projects up through this seat and through the doubletree assembly.

h. The prop bracket to which the limber prop assembly is connected is riveted to the underside of the pole clamp. The limber prop assembly maintains the vehicle in its normal road position when the horses are unhitched and serves to relieve the wheel horses of the weight of the limber pole when standing stationary with the attached vehicle unlim-

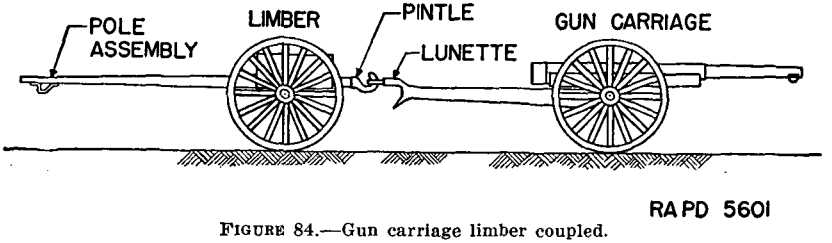


FIGURE 84.—Gun carriage limber coupled.

bered. When not in use, it is swung up under the frame by a chain attached to the lower end of the prop which passes through an opening in the foot rest. A handle on the prop chain hooks over a prop chain button riveted to the left rear side of the bucket holder.

i. In traveling position the pintle of the limber couples with the lunette of the gun carriage or caisson as shown in figure 84. The downward force on the lunette tends to relieve part of the weight on the limber pole borne by the horses. The lug on the rear end of the pintle (fig. 80) bears up against the underside of the lunette, and the pole support spring (fig. 85) supplies an upward rotating force to the pintle, tending to keep the bearing surface on the pintle hook in engagement with the lunette. This spring also supports the weight of the pole. When the limber pole assembly is dropped, the pintle tends to rise, lifting the lunette in it. The pintle bearing is forced to swing on its trunnion bolts and draws the spring rod backwards, compressing the pole supporting spring until the reaction of the spring is sufficient to support the pole assembly and stop the forward tipping of the limber. The supporting spring rod is in the form of a yoke at the rear end where it pins to the bearing.

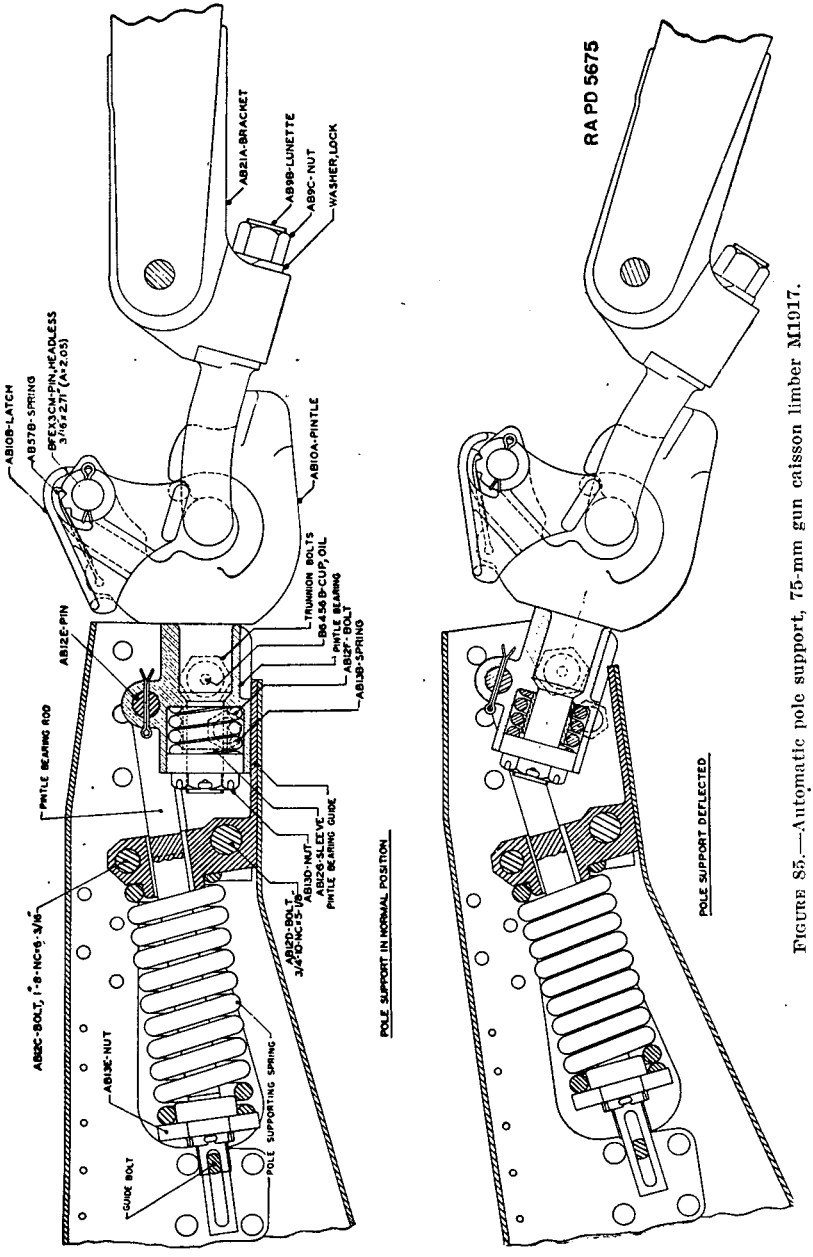


FIGURE 85.—Automatic pole support, 75-mm gun caisson limber M1917.

The pintle bearing is pivoted to the pintle bearing guide by two trunnion bolts. The purpose of the pintle bearing spring is to absorb the shock of starting.

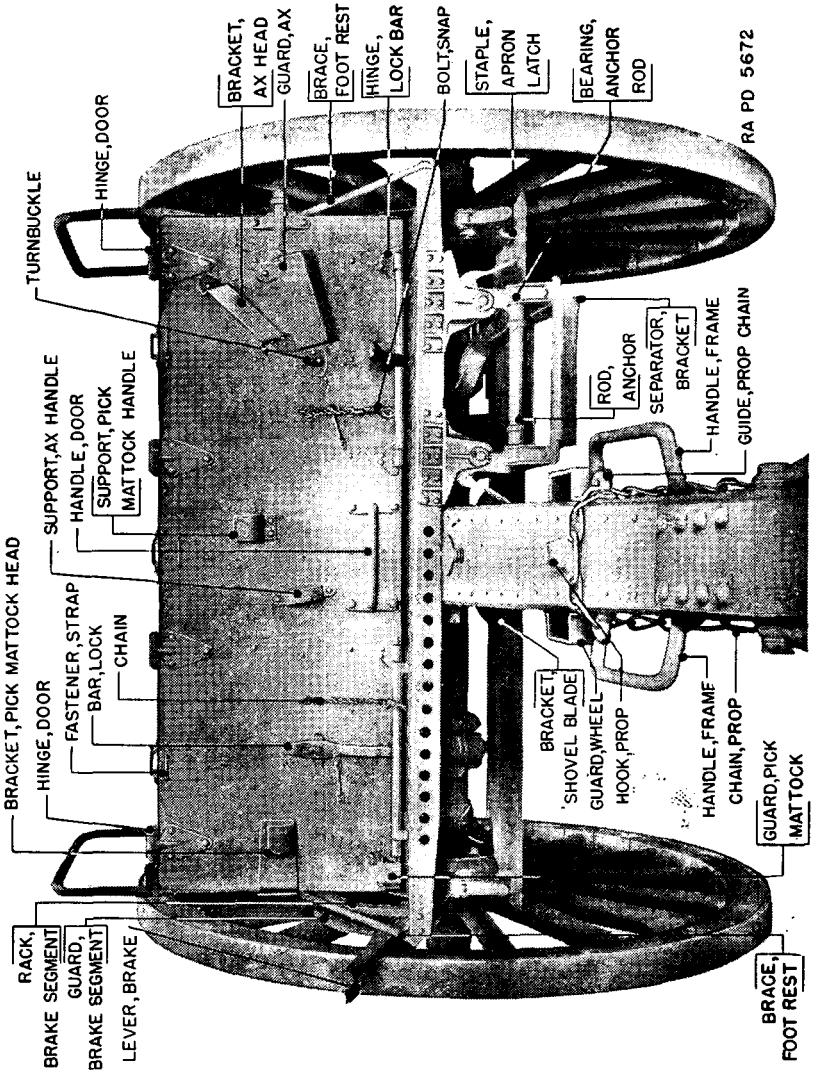


FIGURE 86.—75-mm gun caisson M1918, front.

j. The gun carriage limber chest is a rectangular box built up of plates that are riveted together. The chest carries 18 rounds of ammunition and 3 oil cans.

k. The gun caisson limber chest is substantially the same as that of the gun carriage limber except that the chest is larger and carries 36 rounds of ammunition instead of 18.

l. A name plate is attached to the top of the middle rail of each limber above the pintle bearing.

m. Implement fastenings, attached to the chest and foot rest, are provided for carrying the various accessories.

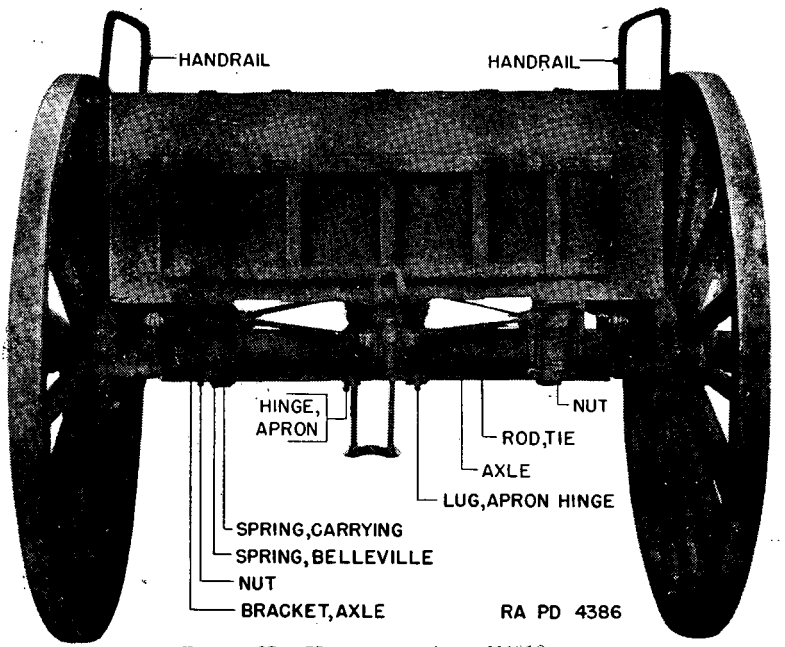


FIGURE 87.—75-mm gun caisson M1918, rear.

85. 75-mm gun caisson M1918 (figs. 86–88).—*a. General.*—(1) With the exception of the spokes and fellies of the wheels, the caisson is metal throughout. Principal parts are the wheels, axle, frame, carrying springs, brakes, ammunition chest, and apron.

(2) Wheels, wheel fastenings, dust guards, pintle and latch, lunette, padlocks, and bolt snaps are described in section II.

b. Frame.—The frame consists principally of two side rails and a middle rail, braced by two tie-rods and also by the ammunition chest. The side rails are riveted to the ammunition chests, forming parts of the chest bottom. The middle rail is made up of two channels connected by the middle rail top plate, with flanges overlapping in rear to form a pintle bearing seat. The front ends are riveted to a lunette bracket in which the lunette is retained by the lunette

nut. The side rails extend the length of the chest. Each has two pairs of vertical guides that straddle the axle and are fitted with liners in which the axle brackets slide. The caisson carrying springs and spring rods are located between the side rails and axle brackets.

c. Pintle.—The pintle has a swiveling motion of 360° upon its shank. It is held in normal position by the pintle spring, a small coiled spring in the pintle bearing which presses a plunger against a flattened seat on the pintle shank. The pintle is retained in the pintle bearing by the pintle nut on the end of the pintle shank. No pole-supporting device is provided.

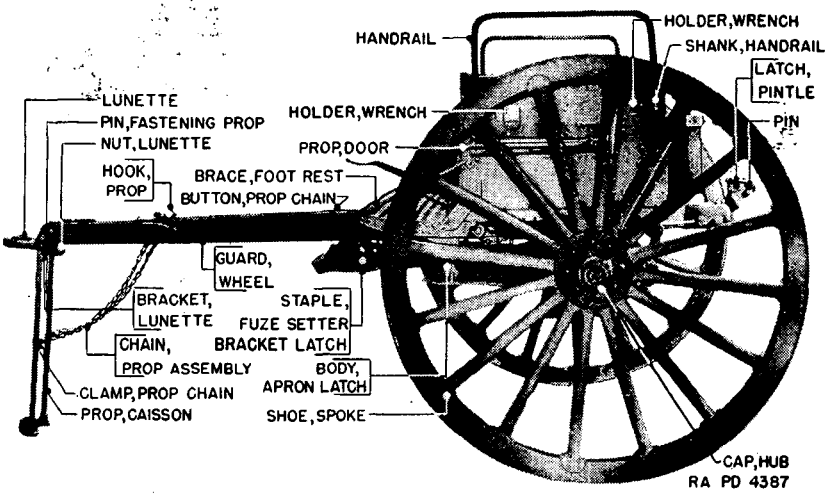


FIGURE 88.—75-mm gun caisson M1918, left side.

d. Carrying springs.—Clamped to the axle at each side rail are axle brackets. Upon each of these are two lugs bored out for the spring rods and counterbored for the caisson carrying springs. These lugs slide up and down between the side rail liners and hold the chest from lateral and horizontal motion with respect to the axle. The four caisson carrying springs assembled on the spring rods are compressed between the axle brackets and the side rails, supporting the chest on the axle and allowing a movement of 0.75 inch. Each spring rod is screwed into a threaded socket in the side rail and secured by one of the rivets used in fastening the bottom plates to the side rails. The spring rod lower end extends below the axle bracket lug through a column of four Belleville springs held in place by a nut on the spring rods. When the caisson is traveling over rough ground, the rebound of the chest from the caisson carrying springs is met by the action of

the Belleville springs, which are compressed between the spring rod nuts and the axle bracket lugs.

e. The brake mechanism is of the external contracting band type, operated from the seat by a brake lever at the right side of the ammunition chest. The brake drums are bolted to the wheels and revolve

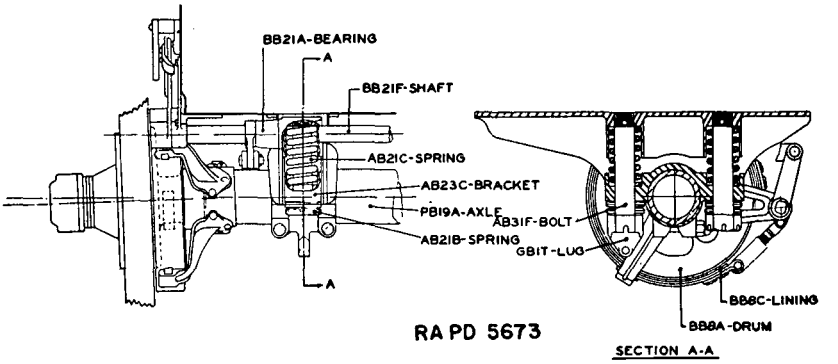


FIGURE 89.—Caisson carrying springs.

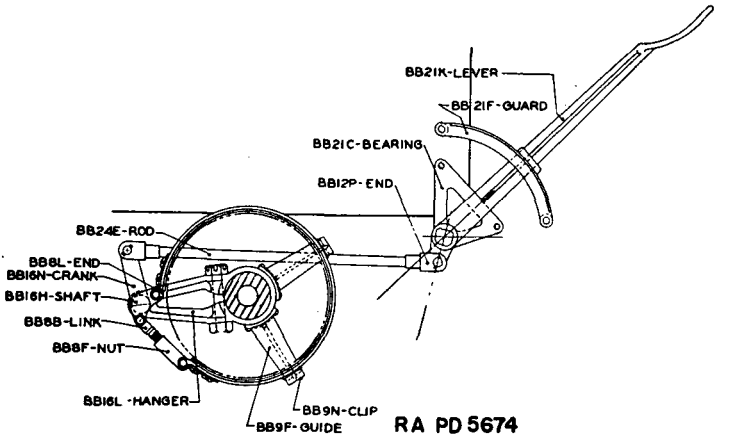


FIGURE 90.—Caisson brake, right.

with them. Brake bands, lined with commercial brake lining, are assembled around the drums and held in place by brake band guides (see fig. 91). Grooves in the brake band clips fit over the guides, preventing lateral movement of guides. The brake band clips also support the brake bands and prevent them from dragging on the brake drums when the brakes are released. The brake hangers are clamped and keyed on the axle. The brake bands are provided with forked ends. The lower ends are attached to the lower arms of the

brake shafts by adjusting nuts and links, and the upper ends are attached directly to the upper arms of the brake shafts. The brake shafts are supported in bearings in the brake hangers. When the brake lever is pulled up, the brake lever shaft turns, moving the brake

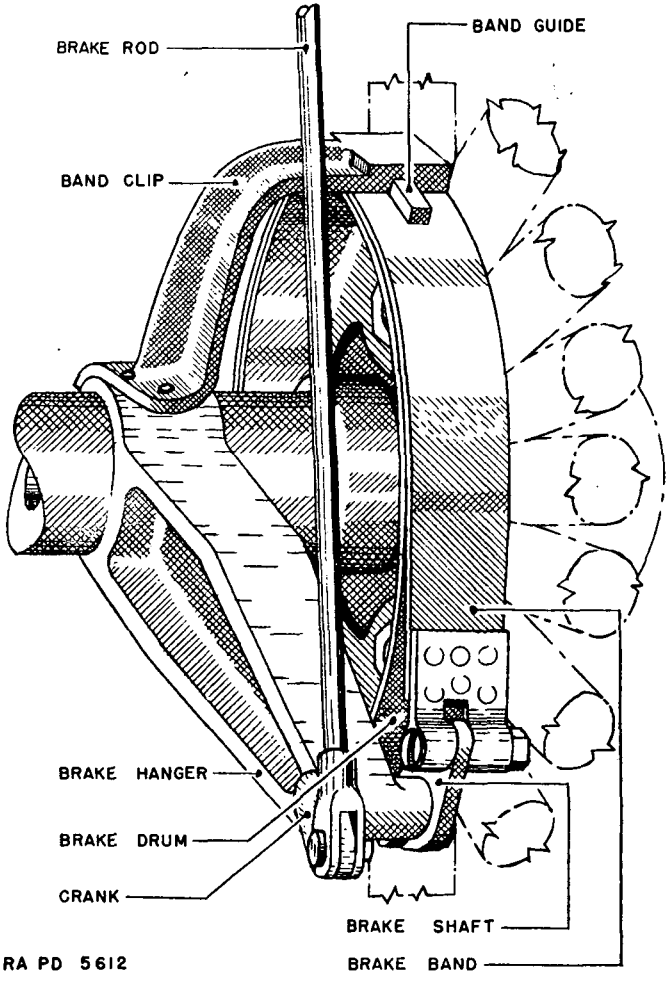


FIGURE 91.—Brake hanger, 75-mm gun caisson.

cranks forward. This motion is transmitted through the brake rods, to the brake shafts, and the brake band ends, compressing them and tightening the brake bands about the drums. The right brake crank is integral with the brake lever shaft, while the left brake crank is a separate piece, pinned in position. The brake rods are provided with

adjustable brake rod ends. The brake lever shaft is supported in the brake lever shaft bearings attached to the right side of the ammunition chest and the foot rest, and in bearings attached to the side rails beneath the front edge of the ammunition chest.

f. The caisson ammunition chest is a rectangular box built up of plates riveted together, with provision for 70 rounds of ammunition arranged in 5 horizontal rows of 14 rounds each. The back and door of the chest are made of armor plate.

g. The top of the chest forms a seat for the gunners and has a handrail at each side. Three grip straps for use of the gunners are attached to strap fasteners riveted to the door and to others riveted to the top of the chest. Three paulin straps are attached for securing the paulin, which serves as a seat cushion.

h. The fuze-box receptacle, a built-up framework for carrying the fuze chests, is riveted to the back of the chest (see fig. 87). The receptacle is provided with adjusters to suit the different types of fuze boxes.

i. The fuze-setter bracket is located beneath the foot rest on the left side of the caisson. The anchor rod rotates in its bearings so that when the anchor bracket is swung up into traveling position, the fuze setter rests on the fuze-setter carrier. When in use, the anchor bracket swings down with its front end on the ground, the fuze setter being inclined about 45°. When the assembly, consisting of fuze setter, anchor bracket, and anchor, is revolved, it can be disengaged from the anchor rod. If the bracket fuze setter is not attached to the anchor bracket in traveling, the bracket must be folded in before the latches are engaged, to prevent movement and possible loss of the anchor bracket assembly.

86. Hand reel M1917.—*a.* The hand reel M1917 (fig. 92) is a hand-operated reel for the transportation and handling of telephone wire. It is bolted to the top of the caisson ammunition chest of two caissons in each gun battery.

b. The reel consists of a frame, with the cranks, gearing, and bearings for the spool mounted on it. The spool shaft bearings are hinged so that the spool can be removed readily and replaced by another spool. The spool consists of two spool flanges and a spool hub, held together by four tie rods and a spool-flange hub riveted to the left spool flange.

c. The crank on the right end of the reel turns a 40-tooth driving gear which meshes with an 18-tooth pinion. This crank folds compactly against the frame. When folded back, the crank is disengaged from the driving gear and does not revolve when the wire is unreeled.

d. The speed of the spool can be controlled by means of the brake.

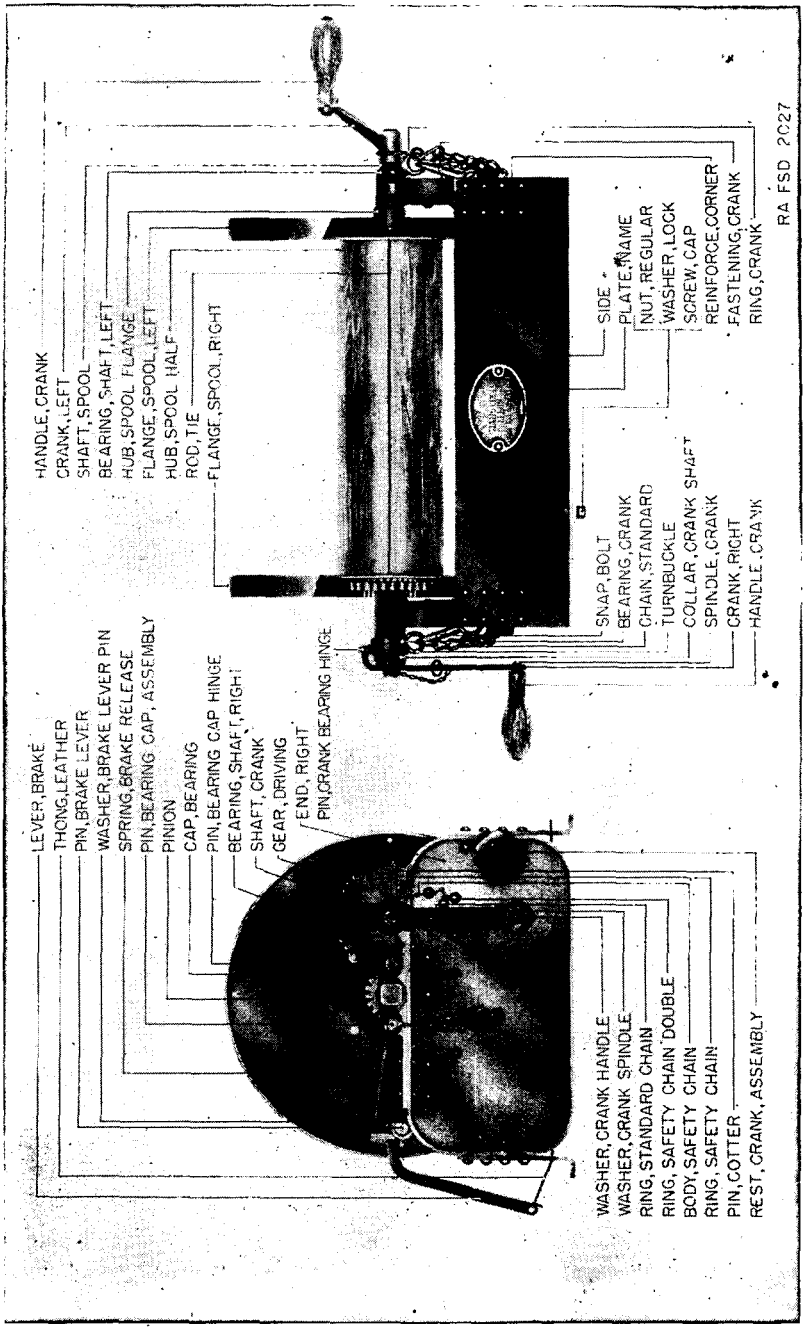


FIGURE 92.—Hand reel M1917.

Actuating the brake lever, which pivots on the brake-lever pin of the right shaft bearing, causes the brake to bear on the inner rim of the right spool flange. The lever is held out of engagement with the spool flange by the brake release spring. For operating the brake mechanism from the seat of the limber a thong or cord may be reeved through the lower end of the brake lever.

87. Battery reel M1917A2 (figs. 93 and 94).—*a.* The battery reel M1917A2 is used in 75-mm gun batteries of horse-drawn artillery. The reel is a two-wheel vehicle, drawn by four horses, designed to carry, lay, and recover 1.7 miles of double insulated wire and to trans-

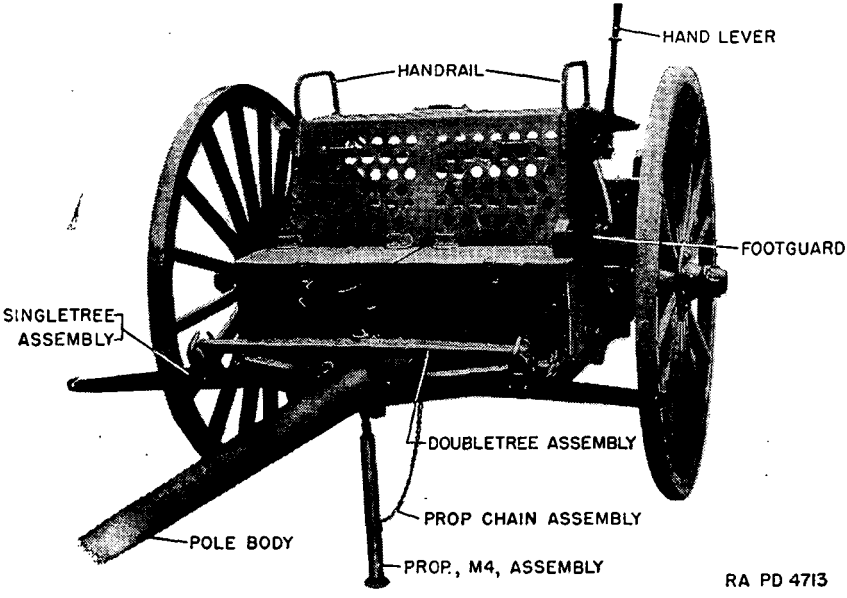


FIGURE 93.—Battery reel M1917A2, front.

port certain other communication, fire-control, and topographical equipment. Principal parts are the frame, drum, operating gear, front chest, rear chest, seat, wheels, pole, doubletree, singletrees, and neck yoke.

b. The wheels, wheel fastenings, pole, pole pin, doubletree, singletrees, neck yoke, padlocks, and bolt snaps are described in section II.

c. The driving gear is bolted to the left wheel hub concentric with the axis of the hub.

d. The frame consists principally of two side rails, the forward ends of which converge and are riveted to the front end of the pole socket. The rear ends are connected by a cross brace. About mid-

way between the front and rear ends of the side rails and riveted to them are the right and left axle brackets on which the wheels are mounted. Behind these, two brackets which support the rear chest are riveted to each side rail.

e. The drum upon which the wire is wound is 1 foot in diameter. Each strand of the double wire is attached to a separate terminal secured to the right drum end plate so that connection with the wire remaining on the drum may be made readily through these terminals.

f. The axle arms are usually set so that the left wheel and attached driving gear are inclined from the vertical to obtain proper tracking

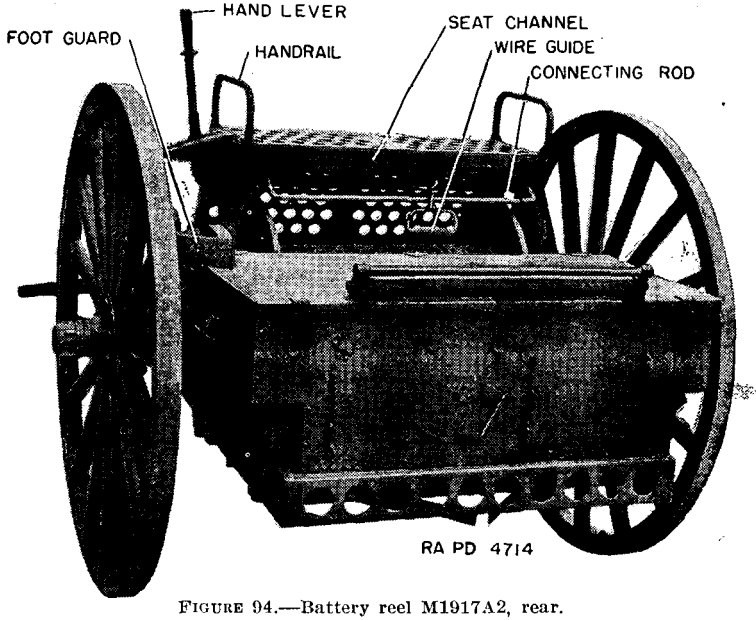


FIGURE 94.—Battery reel M1917A2, rear.

or following characteristics. The left end of the drum is lower than the right end in order to keep the gear axes (and axle axis) parallel. The drum shaft does not rotate. Each drumhead is provided with a ball bearing so the drum may revolve freely upon the shaft. Figure 105 is a cross section of the drum. A conical clutch surface is machined in the exterior end of each drumhead. Two leather-faced sliding cones engage these surfaces, forming a driving clutch on the left drumhead and a braking clutch on the right drumhead. The brake cone is keyed to the drum shaft, on which it slides in or out of engagement with the drumhead. The driving cone is secured to a bushed sleeve (fig. 95) having a pinion on its outer end and free to revolve on the shaft.

g. When the hand lever is thrust to the left, out from the seat, the lower end moves to the right with the driving clutch yoke, bringing the driving clutch cone into engagement with the conical surface in the drumhead. Since the driving clutch cone is directly connected to the pinion, the drum revolves. At the same time, movement of the hand lever pulls the connecting rod and brake lever to the left, throwing the lower end of the brake lever to the right and the brake-clutch cone away from the drumhead. Drawing the hand lever to the right produces the opposite effect. The driving-clutch cone is disengaged

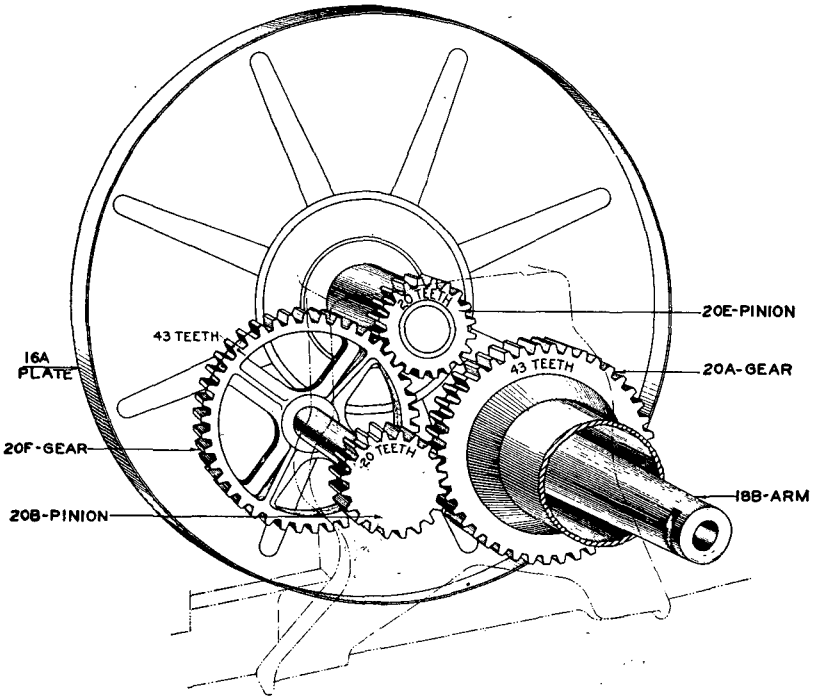


FIGURE 95.—Drive gearing, battery reel M1917A2.

from the drumhead, and the brake clutch cone is brought into engagement with the right drumhead, braking the drum. A rack on the side of the seat support and a catch on the hand lever hold the hand lever in the braked position.

h. The drum is revolved by a train of gears operated by the driving gear attached directly to the hub of the left wheel. The intermediate pinion and gear are mounted on a shaft supported in a bushed bearing in the left axle bracket, the intermediate gear meshing with the driving clutch pinion on the drum shaft. The bears are entirely inclosed by covers.

i. The lower ends of the pairs of lever arms bolted to the hand lever and brake lever form a fork which controls the clutch yoke and brake yoke, respectively. These yokes engage circular grooves on the shanks of the driving clutch and brake clutch cones. The brake lever is connected to the hand lever by a connecting rod running between the two above the drum.

j. The front chest is built up of plates and angles, and is secured to the side rails and lower front flanges of the seat supports. It is divided into two separate compartments, lined on the sides with canvas

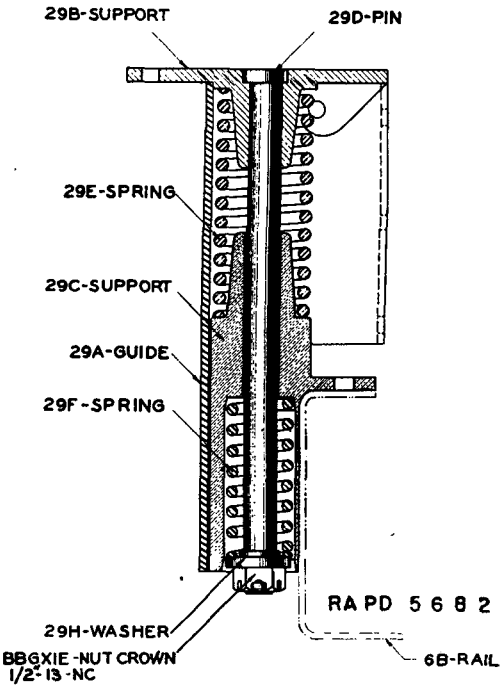


FIGURE 96.—Rear chest support.

pads and on the bottom with a heavy felt pad. Instruments and small stores are carried.

k. The rear chest is larger than the front chest. It is designed to carry large fire-control instruments and some of the smaller ones. The interior is lined similarly to the front chest. A roller, over which the insulated wire is guided, is supported in brackets at the rear of the cover.

l. The upper half of the chest projecting out on either side has spring supports riveted to the horizontal undersurfaces thus formed.

Lower spring supports are riveted to the frame. Four spring columns (fig. 96), which rest in the spring-supports, support the chest, preventing too great a jar either upon impact or rebound when traveling over rough ground.

m. Attached to the seat channel is a guide bar which runs the length of the drum. The wire guide which slides on the guide bar has a handle at the upper end and a twisted ring at the lower end through which the wire passes. The guide is for distributing the cable evenly on the drum.

n. The limber prop, attached to a prop bracket bolted to the pole socket, maintains the vehicle in its normal road position when the horses are unhitched. It is also used to relieve the horses by supporting the pole when standing for any length of time. When not in use, it is swung up under the frame by a chain attached to the lower end of the prop and passing up through an opening in the flange of the pole socket. A handle on the free end of the prop chain hooks over a prop-chain button attached to the front end of the front chest.

o. Implement fastenings attached to the chests and frame are provided for carrying the various accessories. The accessories are held in position by fasteners or by straps attached to the vehicle with strap fasteners.

p. The name plate is attached to the seat channel in the rear of the seat.

88. Artillery reel M1909MI (figs. 97–102).—*a.* The battery reel M1917A2 is replaced by the artillery reel M1909MI and the artillery cart M1918A1 in headquarters units of certain light field artillery, horse-drawn organizations.

b. The reel is designed to carry, lay, and recover 4 miles of 11-strand insulated wire and also to serve as a limber for the cart M1918A1. The cable constitutes the principal load, although various accessories are carried in the tool box or in fastenings attached to the vehicle. With the exception of spokes and fellies of the wheels, the chest packing, and the rollers, the reel is metal throughout. Principal parts are the frame, drums, drum clutch, drum driving mechanism, drum brake, seat, wheels, drawbar or pole, doubletree, singletrees, and neck yoke.

c. Wheels, wheel fastenings, pole, pole pin, doubletree, singletrees, neck yoke, drawbar, and padlocks are described in section II.

d. Standard 56-inch wheels are used with the reel. The driving ring is bolted to the right wheel hub, longer carriage bolts replacing the standard hub bolts.

e. The frame is composed of members riveted together to form a front and a rear frame, joined by the axle brackets.

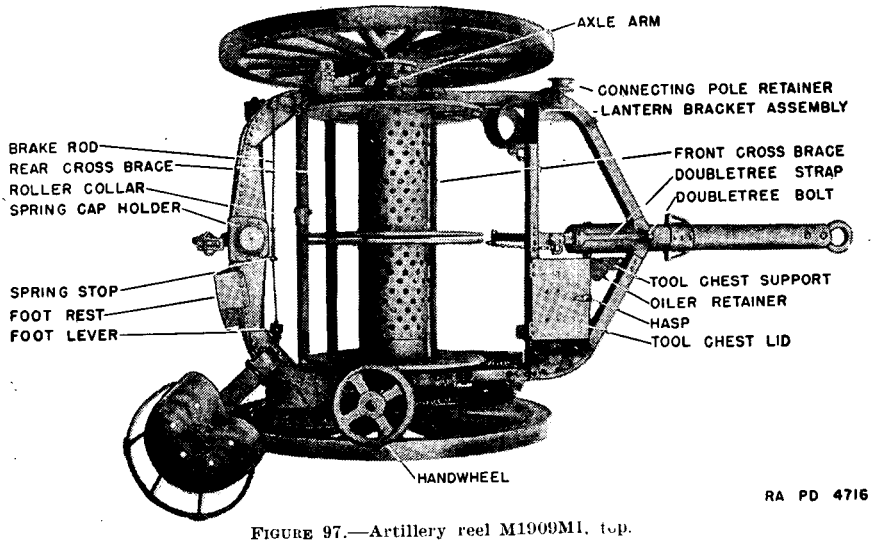


FIGURE 97.—Artillery reel M1909M1, top.

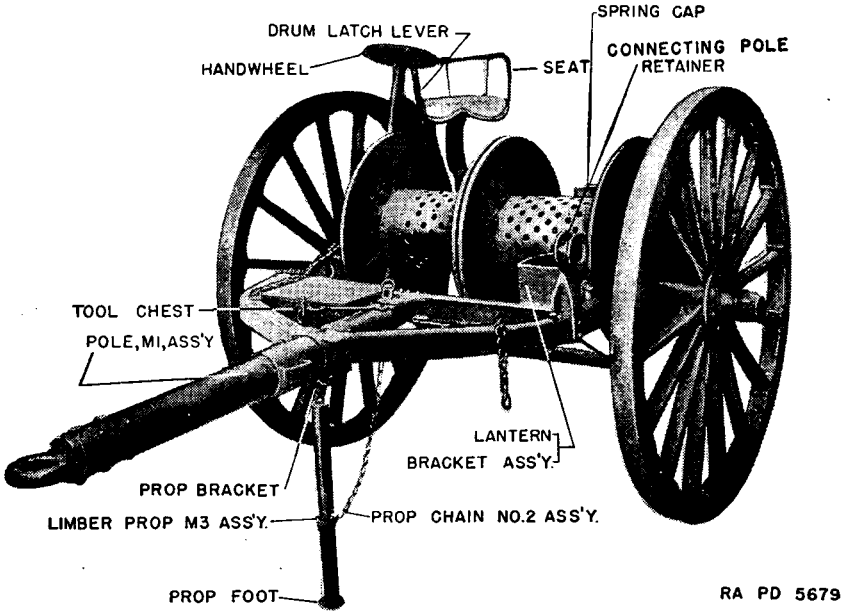


FIGURE 98.—Artillery reel M1909MI, left side.

f. The brackets on the left side for carrying the drawbar are not used, as the bar has been discarded.

g. The pole socket is tightened about the pole assembly by a pole clamp bolt underneath the socket. On this bolt is placed the prop bracket, connected to the prop by the prop eye. When not in use, this prop is swung up under the frame by a chain attached to the lower end of the tube, passing up through the chain eye on the rear end of the pole socket, where it terminates in a prop-chain handle. It is

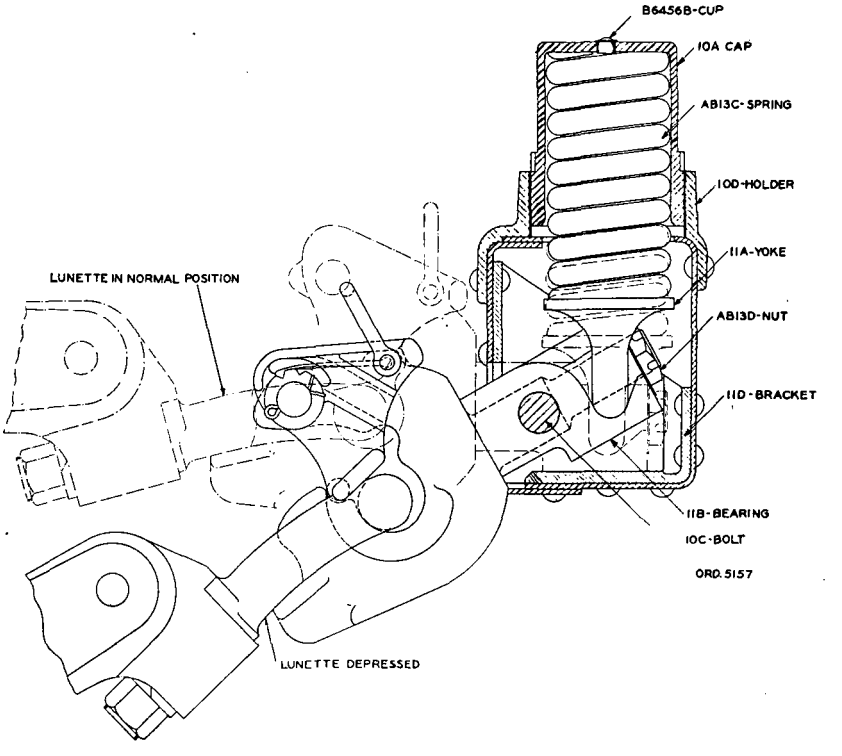


FIGURE 99.—Automatic pole support, artillery reel M1909MI.

held in the raised position by hooking the handle over a prop-chain button on the left side of the frame near the front drawbar bracket.

h. Brackets and a strap are provided on the rear of the front cross rail so that the prop used under the front end of the horse pole can be carried when not in use.

i. When limbered with another vehicle, the pintle acts as an automatic pole support. The pintle hook has a lug on its lower side which projects backward and bears against the underside of the lunette on

the drawn vehicle. This prevents rotation of the reel about its wheel axle, which would lower the pole or drawbar. The pintle body has an adjusting bolt for adjusting the height of the pole.

j. The pintle bearing is fitted with trunnion bolts which retain it in place, but permit it and the attached pintle to rotate vertically through an angle of approximately 45°. This movement is controlled by a pole supporting spring mounted vertically on the shank of a pole supporting spring yoke (see fig. 99). Prongs of the yoke are held in recesses in the pintle bearing by the compression of the spring which is held in place by the pole supporting spring cap. When the pole is dropped, the pintle tends to rise. Being held down, however, by the lunette, the pintle bearing is forced to swing on its trunnion bolts and forces the spring yoke upward, compressing the pole supporting spring until the reaction of the spring is sufficient to support the pole. A smaller pintle bearing spring acts between the pintle and pintle bearing to absorb the shock of starting.

k. A tool chest with lid on top is assembled in the space on the right side of the pole socket between side rail and front cross rail.

l. A wooden roller to protect the wire when it is being laid or recovered is suspended from brackets beneath the rear cross rail. A similar but smaller roller is supported in brackets attached to the rear cross rail immediately in front of and above the rear roller.

m. Midway between the automatic pole support and gusset plates on the inner rear cross rail two handholes have been cut to allow access to the trunnion bolts holding the pintle bearing in position. These holes are closed by covers secured by screws.

n. The top tube of the three parallel tubes connecting the axle brackets serves also as an axle for the drums.

o. The drums rotate on four roller bearings on the axle. The drum is driven from the wheel axle sprocket to the jackshaft sprockets and from the jackshaft sprockets to the drum sprocket.

p. The wheel axle sprocket is driven by four pins in the driving ring which is bolted to the hub of the right wheel. These pins assemble in holes in the axle sprocket to drive it. Owing to angularity of the axes of the wheel and axle sprocket, the driving pins work in and out of the sprocket holes as the wheel revolves.

q. The jackshaft frame is bolted in the right front side rail. The frame has a sliding movement of ¼ inch as an adjustment for tension of the chains.

r. The clutch connecting the drum driving gear and the right drum is located in a recess in the right drumhead behind the revolving sprocket ring. The drum is rotated from the drum sprocket through

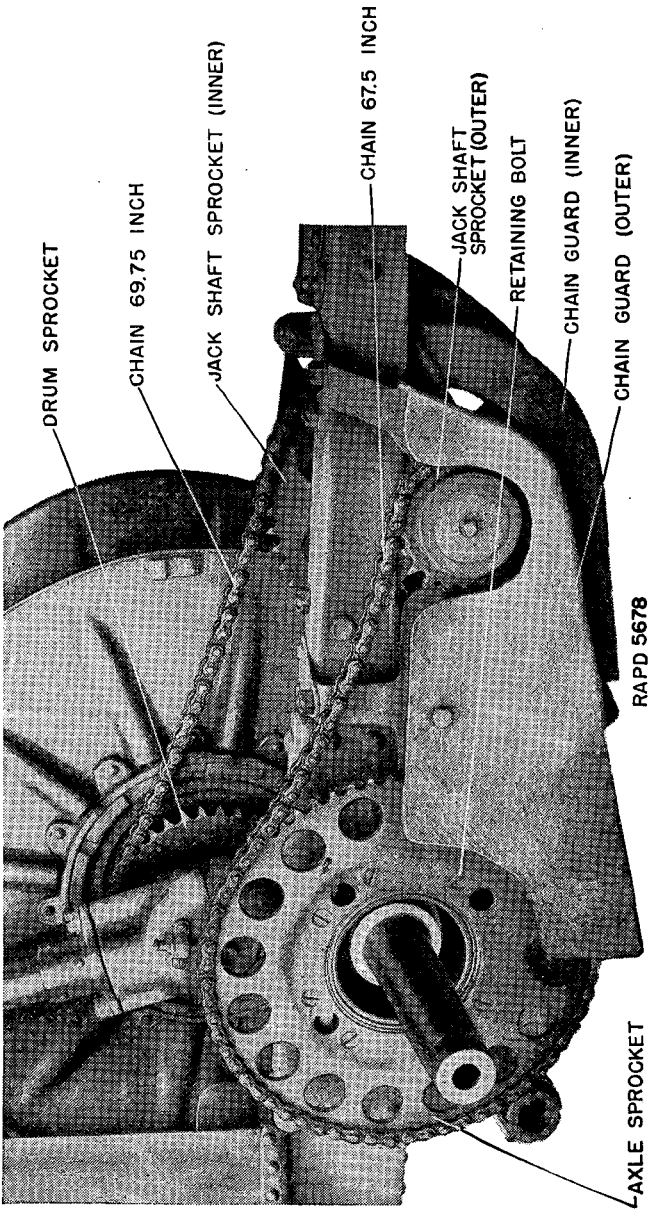


FIGURE 100.—Drive sprockets, artillery reel M1909MI.

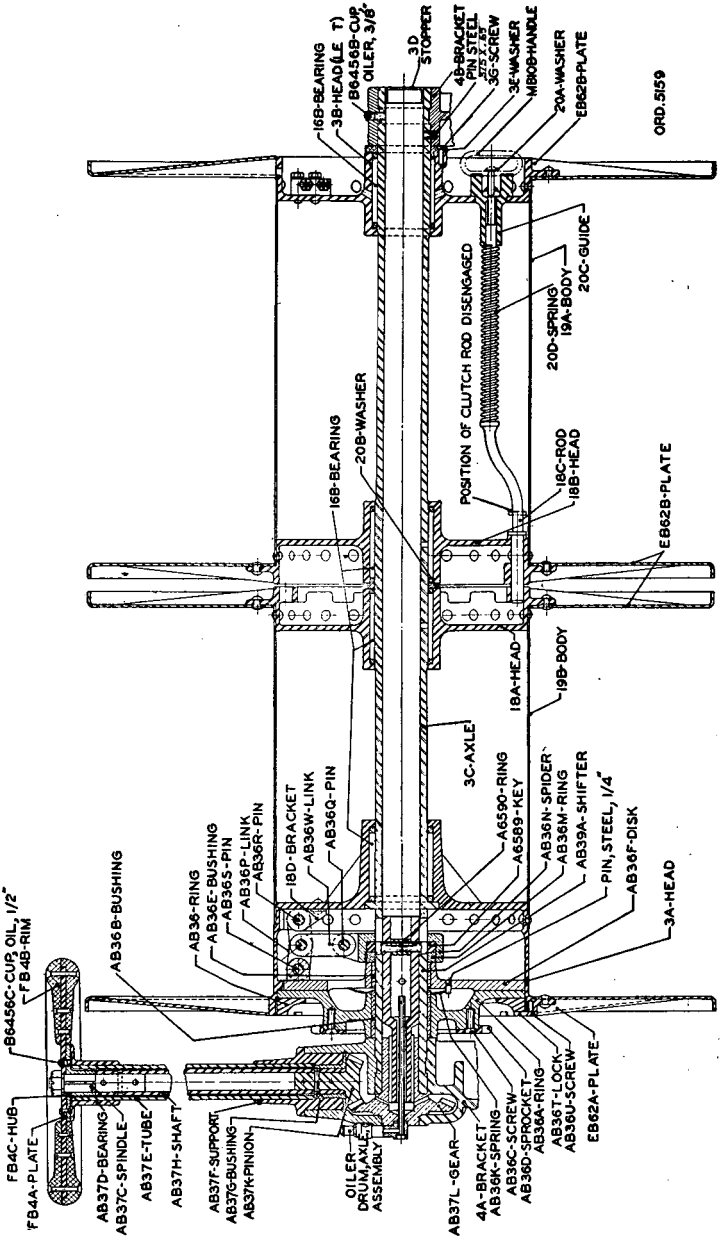


FIGURE 101.—Artillery reel M1909MI, section through drum and clutch.

the clutch to the drum. The sprocket is attached to the sprocket ring by screws. The outer circumference of this ring forms the center plate of the clutch. It is assembled between the clutch adjusting ring and the friction disk which engage the sprocket ring during clutching by closing together. The action of the clutch is as follows: The clutch

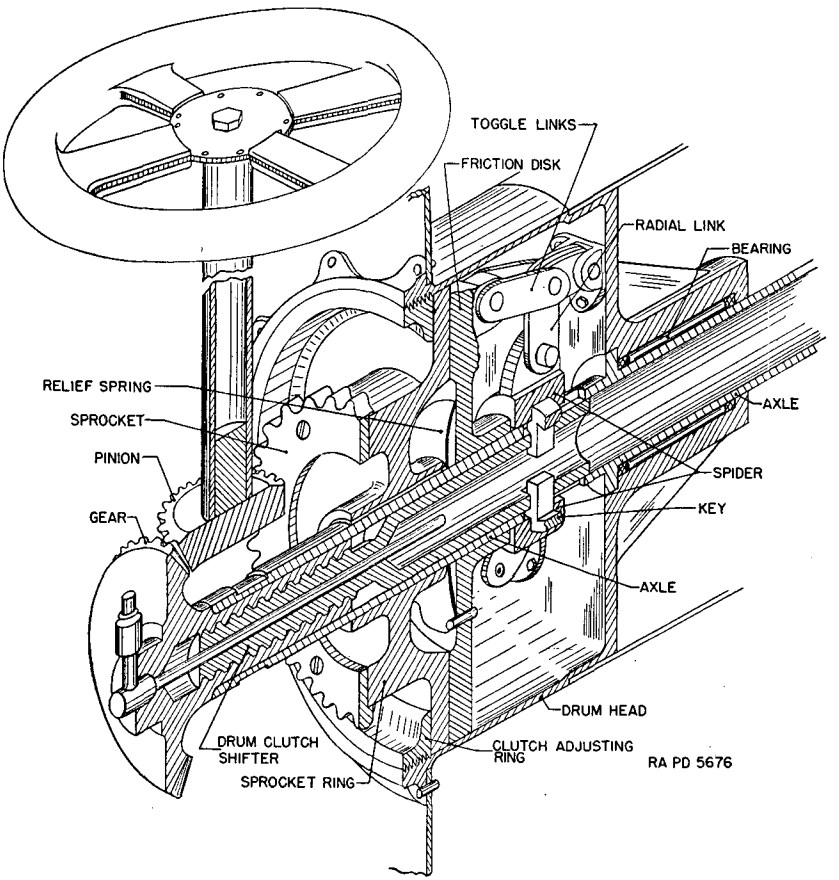


FIGURE 102.—Reel clutch mechanism, artillery reel M1909MI.

shifter gear (fig. 102) causes the shifter to move in or out inside the drum axle. The shifter carries the sliding keys with it, acting through a slot in the hollow axle. The keys engage the spider and work the toggle linkage, causing the friction disk to tighten against the sprocket ring in clutching or away from the sprocket ring in declutching. The clutch adjusting ring is threaded into the end of the recessed drumhead so that when the clutch is engaged the drum revolves with the

sprocket. The shaft and shifter do not rotate; the spider and friction disk rotate with the sprocket when the clutch is engaged.

s. The right drum may be revolved singly or both drums may be revolved simultaneously by engaging the left drum to the right drum. This is done by a second clutch consisting of a rod passing through the left drum and engaging the left drumhead of the right drum.

t. The drum latch lever on the right side near the seat (fig. 98) operates a drum latch for locking the right drum. Movement of the drum latch lever engages or disengages a spring plunger with a projection piece riveted to the right drum end plate. The lever is held in position

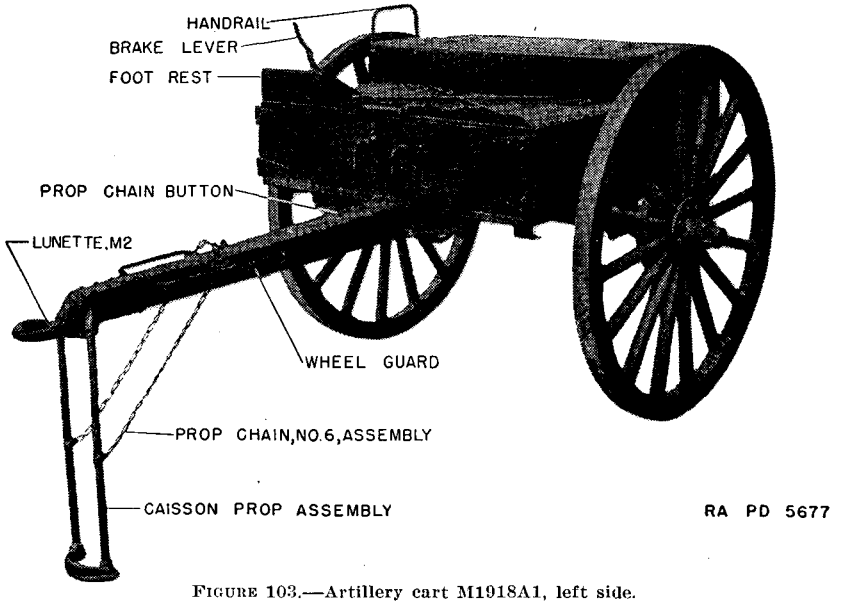


FIGURE 103.—Artillery cart M1918A1, left side.

to lock or free the drum by the drum latch pawl which engages notches in a segment riveted to a flange of the leg guard gusset. Attached to the drum latch lever is a leather-faced brake shoe which comes against the flanged rim of the right drum end plate to act as a brake. A brake shoe which engages the rim of the left drum end plate is controlled by the foot lever near the operator's seat (fig. 97).

u. The end of the cable passes through a hole in the drum body at the left end of the left drum and is secured with a cable clamp. Clips riveted on the ends of the drum plates are used to hold loose ends of cables.

v. The name plate is attached to the lid of the tool box.

89. Artillery cart M1918A1 (figs. 103 and 104).—*a.* The cart, which limbers to the artillery reel M1909MI, is a two-wheeled vehicle designed to carry part of the fire-control, communication, and topographical equipment of the organization to which it is issued. Except for spokes and fellies of the wheels and chest packing, the cart is metal throughout. Principal parts are the frame, carrying springs, chest, brakes, and wheels.

b. Wheels, wheel fastenings, pintle and pintle latch, lunette, and padlocks and bolt snaps are described in section II.

c. The frame is similar in many respects to that of the 75-mm gun caisson M1918 described in paragraph 85. The axle, carrying springs,

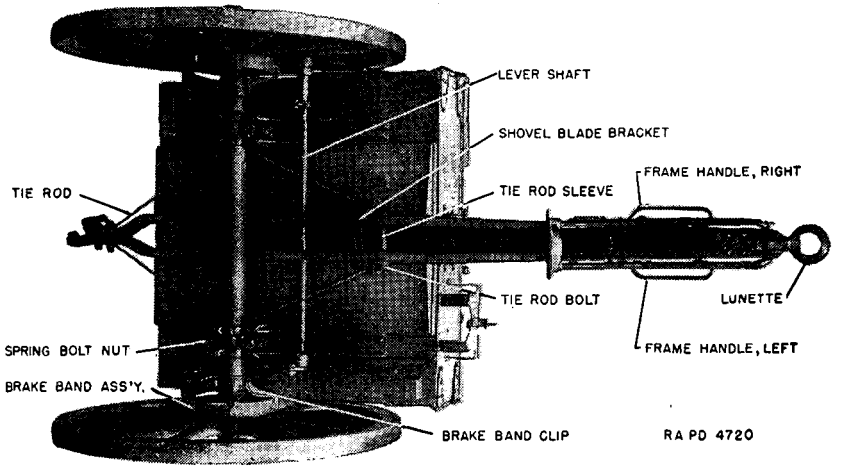


FIGURE 104.—Artillery cart M1918A1, bottom.

axle brackets, lunette, prop, pintle, pintle bearing, brake bands, brake hangers, brake shafts, and a number of the other minor brake parts of the two vehicles are interchangeable. Middle and side rails are similar in design but longer than those used on the caisson. The side rails transmit the weight of the chest and load to the axle through the carrying springs.

d. The cart chest is a rectangular box built up of plates and angles riveted together. The rear half of the chest is higher than the front half. Doors opening outward in both the front and rear allow access to the interior of the chest, which is divided into 17 compartments. The doors are held firmly closed against the chest by lock bars. Bolt snaps and padlocks are furnished for securing the lock bars. Compartments of the chest contain drawers for carrying the fire-control instruments and material. Drawers and supports for the optical

instruments are padded with felt pads, and in addition are supported by conical helical springs which absorb the shocks and vibrations in traveling. For reference, the compartments entered from the rear of the chest may be numbered from the left to the right, Nos. 1 to 12, inclusive, and those entered from the front, from right of the vehicle to the left, Nos. 12 to 17, inclusive.

e. Fastenings for carrying the various accessories are attached to the exterior of the chest and to the frame.

f. The name plate is attached to the top of the middle rail top plate in front of the chest.

SECTION IV

OPERATION

	Paragraph
Operation of hand reel	90
Instructions for laying and recovering wire with battery reel M1917A2	91
Operation of battery reel M1909M1	92

90. Operation of hand reel.—*a.* In laying out wire, the left crank is removed and placed in the clips on the left end of the frame, the cotter pin is removed from the end of the driving gear, and the right crank is folded back and placed on the crank rest. The drum is then free to revolve. Speed of the drum in paying out the wire is controlled by action of the brake.

b. In recovering the wire, place the right and left cranks in position. Revolving the left crank operates the driving gear. Revolving the right crank operates the spool directly.

91. Instructions for laying and recovering wire with battery reel M1917A2.—*a. To lay wire.*—Loosen the free end of the wire and pass it back between the roller and the roller cross brace on the rear chest. Tie it to a tree or any other convenient anchor. Make sure the hand lever is in the neutral position and drive the vehicle over the route desired.

b. To recover wire.—In the initial winding of the wire, the end to go on first is passed between the roller and roller cross brace and through the helix of the wire guide; then through a hole in the right drum end-plate where the twin wires are separated and the ends attached to the two insulated binding posts provided. Revolving the drum winds on the wire. By moving the wire guide back and forth along the guide bar, the wire is evenly distributed on the drum.

92. Operation of battery reel M1909M1.—*a. To reel wire.*—For the initial assembly of wire on the left drum, the end of the cable is carried down through a hole in the outer drumhead to the telephone connections. The end of the wire of the right drum may be threaded

through the perforations of the drum body and tied. Jack up the right wheel, couple the drums, engage the clutch, and rotate the wheel in the direction in which it turns when the vehicle is moving forward.

b. To unreel wire.—Release the drum latch and disconnect the left drum from the right so that either drum rotates freely. Pass the free end of the wire over the forward roller and under the rear roller. Unwind sufficient wire to allow tying to a tree or other anchor.

c. Adjustment of driving clutch.—(1) When the clutch handwheel is turned counterclockwise, its rotary motion turns the drum shaft shifter bevel gear, which acts as a nut, engaging the threads of the drum clutch shifter. The drum clutch shifter is drawn to the right, carrying with it the sliding keys and spider of the clutch. The radial links, attached to the spider, force the inner toggle links to straighten into line, forcing the friction disk against the sprocket ring and the latter against the adjusting ring. The adjusting ring may be screwed into the drumhead to vary the distance between it and the toggle brackets. This distance must be carefully adjusted so as not to allow forcing of the toggles beyond dead center. At the same time the friction between the disks must be sufficient to drive the drum without slippage. The adjusting ring has 12 threads per inch and 12 notches for the small blocks which lock it to the drumhead. It may be moved, therefore, distances which are multiples of $\frac{1}{144}$ inch.

(2) If the clutch habitually slips—

(*a*) Take out the drum clutch adjusting ring lock screw and the adjusting locks.

(*b*) Turn the clutch handwheel counterclockwise as far as it will go to full engagement of the clutch.

(*c*) Using the large spanner, engage the notches of the adjusting ring and turn it into the drumhead until the adjusting ring locks can be mounted in the next set of notches. Then revolve the handwheel to a free position. Engage it again to test the drag of the clutch. When satisfactory, reassemble the adjusting ring locks and set the metal of the locks into the slots of the screws to prevent their coming loose.

SECTION V

DISASSEMBLY AND ASSEMBLY

	Paragraph
Parts common to several vehicles	93
75-mm gun carriage and caisson limber M1918 automatic pole support	94
75-mm gun caisson M1918A1	95
Battery reel M1917A2	96
Artillery reel M1909MI	97
Artillery cart M1918A1	98

93. Parts common to several vehicles.—*a. To dismount wheel from axle.*—(1) Jack up the vehicle until the wheel is clear of the ground, block against movement, and release the brakes.

(2) Pull out on the ring of the plunger of the hub cap to disengage the plunger from the hub ring and unscrew the hub cap, using the hub-cap spanner wrench if necessary. The old type hasp-cap is removed by lifting up the hub latch to disengage the plunger from the hub ring and unscrewing the hub cap.

(3) Disengage the spring plunger of the wheel fastening by inserting a screw driver blade or similar tool under the exposed portion of the plunger, then force up and remove the wheel fastening.

(4) Remove the wheel. The weight of the wheel is about 225 pounds.

(5) To disassemble the wheel further, refer to figure 78. Spokes may be replaced but no attempt will be made to disassemble the tire or fellies of the wheel rims.

b. To assemble wheel on axle.—(1) Reverse the procedure outlined in *a* above.

(2) Make sure the axle arm and the inside of the hub are clean and that fresh lubricant is applied to the axle arm before slipping the wheel on.

(3) Note and report any cutting of the axle arm or wheel fastenings.

(4) Be sure the plunger of the hub cap is locked.

c. To dismount pole.—(1) Loosen the pole-clamp bolt nut.

(2) Withdraw the cotter pin of the pole pin and drive out the pole pin.

(3) Withdraw the pole. The pole weighs approximately 58 pounds.

d. To assemble pole.—(1) Reverse the procedure outlined in *c* above.

(2) Make sure the pole, pole pin, and pole socket are clean.

(3) The pole should be straight and tightly clamped in the bracket.

e. To dismount doubletree.—(1) remove the pole as outlined in *c* above.

(2) Unscrew the nut of the doubletree bolt and drop the bolt into the pole socket.

(3) Lift off the doubletree.

f. To mount doubletree.—(1) Reverse the procedure outlined in *e* above.

(2) In reassembling the doubletree bolt, be sure the dowel which prevents the turning of the bolt when the nut is screwed on is in its proper guide position. Failure to do so may result in damage to the pin. Also note that the doubletree strap does not rest on the shoulder of the doubletree bolt.

g. To dismount neck yoke.—Raise the neck yoke counterstop and slip off the neck yoke.

h. To mount neck yoke.—Slip the center ring of the neck yoke over the end of the pole. The ring will raise the counterstop as it goes over the pole.

i. To replace neck yoke counterstop and spring.—(1) Cut off the riveted head of the neck yoke counterstop pin and drive out the pin.

(2) Replace the stop or spring and assemble in position with a new counterstop pin.

(3) Rivet over the ends of the counterstop pin.

j. To dismount lunette.—(1) Remove the lunette nut and lock washer.

(2) Drive out the lunette.

k. To replace lunette.—(1) Reverse the procedure outlined in *j* above.

(2) Care should be taken in replacing the lunette to see that the broad lug which prevents the lunette from turning is on top.

l. To dismount pintle.—(1) In removing the pintle it will be necessary to remove the automatic pole support assembly from the middle rail by taking out two ⅜-inch fillister head cap screws and removing the lock plates. After this the two pintle trunnion bolts and two pintle bearing bolts can be removed.

(2) Remove the ¾- and 1-inch diameter bolts which pass through the pintle bearing guide. For replacement purposes and in new equipment, standard cap screws ¾-10NC-2 by 5¼ inches and 1-8NC-2 by 6¼ inches with slotted nuts and split cotter pins will be used in place of these two bolts.

(3) Remove the guide bolt and withdraw the pintle and automatic pole support from the middle rail.

(4) Remove the cotter pin and spring rod pin, disconnecting the pintle from the automatic pole support.

(5) Place the pintle in a vise or pass a bar through the mouth of the pintle to keep it from turning and unscrew the pintle nut.

m. To replace pintle.—Reverse the procedure outlined in *l* above.

n. To dismount pintle latch.—(1) Open the pintle latch.

(2) Remove one of the cotter pins from the pintle latch pin and drive out the pin.

(3) Pull the pintle latch off toward the front.

(4) Take care not to damage the spring.

o. To replace pintle latch.—Reverse the procedure outlined in *n* above.

p. To replace pintle latch spring.—(1) Remove the pintle latch as outlined in *n* above.

(2) Drive out the old spring with a punch and replace.

(3) Take care in driving in a new spring to use a copper hammer or to interpose a block of wood to prevent damage to the spring.

q. To remove padlock or bolt snap from its chain.—(1) Take out the padlock clevis or cut the chain ring.

(2) The chain assembly, as formerly made up and issued for repairs, included a bolt snap, two chain rings, and a chain rivet. Now, however, chain repair assemblies substitute "S" hooks for the chain rings. "S" hooks may be opened sufficiently by twisting slightly, and are easily closed after assembling.

94. 75-mm gun carriage and caisson limber M1918 automatic pole support.—*a. To dismount automatic pole support.*—(1) Remove the pintle bearing guide bolt (fig. 85).

(2) Remove the two cap screws which pass through the guide.

(3) Remove the two pintle trunnion bolts.

(4) Pull the mechanism out to the rear.

(5) Remove the spring-rod nut and spring.

(6) Remove the pintle nut and spring and withdraw the pintle.

b. To mount automatic pole support.—(1) Reverse the procedure outlined in *a* above.

(2) There is sufficient thread on the spring rod so the spring-rod nut will engage when the pole supporting spring is free.

(3) Expansion of the pintle bearing spring is not so great as to interfere with reassembling of the pintle nut.

(4) See that all oil passages are clean and that the pintle and spring-rod and cotter pins are in position.

(5) Grease the pole supporting spring, pintle bearing spring, and the spring rod. Oil all moving parts.

(6) Assemble all the through bolts from the left side.

c. To adjust automatic pole support.—(1) As manufactured, the automatic pole support holds the pole assembly constantly at a height of 29.25 inches without support from the harness when the limber and caisson props are in traveling position. When inspection shows that the pole assembly is not supported at the proper height, the cause should be determined and the necessary corrections made. One or both of the following causes will probably be found:

(*a*) Pole loose in pole socket, or pole bent.

(*b*) Automatic pole support spring not properly adjusted.

(2) In adjusting the automatic pole support, proceed as follows:

(*a*) Clamp the pole assembly in the pole socket.

(*b*) Clean and lubricate all parts, and see that they move freely.

(*c*) Adjust the compression of the pole-supporting spring to support a 20-pound weight suspended from the pole assembly at the neck yoke stop.

(*d*) The pole supporting spring is compressed by tightening the spring rod nut. To do this, dismount the automatic pole support as outlined in *a* above.

(3) If the pole assembly still droops, the lug of the pintle or the bottom of the lunette, or both, are worn. If this is the case, place shims between the lug of the pintle and the lunette to bring the pole assembly to the desired height. Take a piece of steel about 1¼ inches wide, the thickness of the shims, and long enough to forge around the lug and down and over the main part of the pintle proper. When the steel cools, it will shrink on the pintle and make a close fit without necessity of rivets or pins. In an emergency, a piece of horseshoe can be used successfully for this purpose.

(4) The method of adjusting the automatic pole support when the vehicle is equipped with the modified pintle M4A1 is to adjust the height of the pole to approximately 29½ inches by adding shims (three are furnished with each modified pintle), if necessary, under the head of the bolt. Measure from a level floor to the center of the pole when the vehicle is limbered with another vehicle. The square head of the adjusting bolt may be turned to a fresh wearing surface, and full service should thus be obtained before replacing the bolt.

d. Axle bracket bolts.—For replacement of the four axle bracket clamping bolts use standard cap screws 5/8-11NC-2 by 4 inches with regular hexagon nuts.

e. Instructions on disassembling and assembling of wheels, wheel fastenings, pole, doubletree, singletrees, neck yoke, pintle latch and spring, padlocks, and bolt snaps are contained in paragraph 93.

95. 75-mm gun caisson M1918A1.—*a. To dismount brake band.*—(1) Remove the wheel (see par. 93).

(2) Remove the cotter pins of the brake band end pins and the rear brake rod end pin (see fig. 90).

(3) Drift out the brake rod end pin and lower the brake band end.

(4) Swing the outer crank to the rear, raising the upper brake band end pin.

(5) Drift out the upper brake band end pin.

(6) In the first brakes of this model the adjusting nuts were attached to the brake band end by a straight pin held by a cotter pin in the adjusting link, which engaged a notch in the pin. The straight

pin is now replaced by a bolt with a thin head and nut. The head is assembled on the outside and just clears the spokes.

b. To assemble newly relined brake band.—(1) Reverse the procedure outlined in *a* above.

(2) Loosen the adjusting link. Then be sure the adjusting nut is assembled to the proper end of the band so that when the adjusting link is assembled to the lower arm of the brake shaft the brake band guides enter the clips.

(3) Smooth all burs and rough spots off the brake drum, but do not put oil or grease on it or the lining.

c. To dismount brake shaft.—(1) Remove the wheel.

(2) Remove the cotter pins from the rear brake rod end pin (fig. 90) outer crank. Then remove the brake rod end pins.

(3) Drive out the brake rod end pin and the brake band end pins.

(4) Remove the outer crank.

(5) Drive out the brake shaft.

(6) It is possible to remove the brake crank and the brake band as a unit, without removing the brake band end pins. Revolve the brake crank, moving the brake band so that the brake band guides clear the clips. Pull out the unit.

d. To assemble brake shaft.—(1) Reverse the procedure outlined in *c* above.

(2) Clean all bearing surfaces and lubricate parts before assembling.

e. To dismount pintle.—(1) Remove the pintle bearing bolts, and withdraw the pintle and bearing to the rear.

(2) Unscrew the pintle spring seat in the top of the pintle bearing, and take out the small spring and plunger.

(3) Remove the pintle nut and withdraw the pintle from the bearing.

f. To replace pintle.—Reverse the procedure outlined in *e* above.

g. To replace carrying spring.—(1) Remove the apron by withdrawing the apron hinge pins.

(2) Disconnect the brake rods.

(3) Remove the cotter pins and nuts from the lower ends of the spring bolts (fig. 89). The Belleville springs come off with the nuts.

(4) Raise the chest and frame from the axle sufficiently to remove the broken spring and insert a new one.

(5) Examine all the springs, the axle brackets, and the liners of the side-rail guides for scoring and wear of the contact surfaces. Smooth off any roughness or burs.

(6) Clean the springs and slush with grease, graphite, medium.

(7) Coat the axle brackets and the liners of the side-rail guides lightly with medium graphite grease, and follow by oiling lightly with oil, engine, SAE 10.

(8) Reassemble the Belleville springs and the spring-bolt nuts. The Belleville springs are to have the convex side next to the axle brackets and the spring bolt nuts. Screw on the nuts until flush with the ends of the spring bolts. Insert the cotter pins.

(9) If the weight of the chest without ammunition is insufficient to compress the carrying springs so that the spring bolt nuts cannot be started on the thread, have a number of men sit on the chest to weight it down, or use any convenient weight. Replace the cotter pins.

(10) Replace the apron and connect the brake rods.

h. Instructions on disassembling and assembling of the wheels, wheel fastenings, pintle latch and springs, lunette, and padlocks and bolt snaps are contained in paragraph 93.

96. Battery reel M1917A2.—*a. To dismount rear chest.*—(1) Remove the contents of the chest to reduce the weight and to facilitate handling.

(2) Remove cotter pins, nuts, and washers from the rear chest support pins. The lower carrying springs will drop out.

(3) Lift the chest vertically until the rear chest support pins clear the upper carrying springs seated on the lower rear chest supports.

b. To remount rear chest.—(1) Clean the springs, support pins, and spring chambers in the upper and lower rear chest supports and examine for scoring or excessive wear.

(2) Clean the springs and spring chambers and slush with grease, graphite, medium.

(3) Place the upper carrying springs in position in their seats on the upper rear chest supports.

(4) Lubricate the support pins and their bearings in the lower rear chest supports with oil, engine, SAE 30 or SAE 50 (see lubricating instructions, par. 105).

(5) Lower the chest in position, taking care to line up the support pins with their bearings in the lower rear chest supports.

(6) Assemble the lower carrying springs, support pin washers, nuts, and cotter pins in position. It may be necessary to have several men sit on the chest to compress the upper carrying springs so as to lower the support pins enough to replace the nuts.

c. To dismount wheels.—(1) The left wheel is restrained by the driving-gear case. Remove the four cap screws and lock washers holding the case. For replacement use standard cap screws ½-13NC-2 by 3¾ inches with lock washers.

(2) Remove the wheels as outlined in paragraph 93*a*.

d. To replace wheels.—(1) Clean and slush the teeth of the driving gear attached to the left wheel hub, with grease, graphite, medium.

(2) Replace the wheels as outlined in paragraph 93*b*.

e. To dismount drum.—(1) Remove the rear chest as outlined in *a* above.

(2) Remove the four bolts holding the wire guide bar. On earlier vehicles this bar was riveted in place. Cut out the rivets, and in reassembly use standard cap screws ⅜-16NC-2 by 1 inch with regular plain nuts and lock washers.

(3) Remove the clutch yokes from the cones (see fig. 105). The hand lever bracket and brake lever bracket are fastened by two ½- by 1⅜-inch bolts each. Take these out and raise the whole cone shifter mechanism up and out of the way. For replacement use standard cap screws ½-13NC-2 by 1⅜ inches in the hand and brake lever brackets.

(4) Take out the two drum shaft bolts. To do this, it is necessary to take off the wheels as outlined in *c* above. The hexagon head of each drum shaft bolt is locked with a fillister head screw. Mark each bolt so it will be reassembled in the same axle bracket. Put a plank or two (plank to be approximately 8 feet long) under the drum and over the rear cross brace and use this as a lever to prevent the drum from dropping when the drum shaft bolts come out. The cones may then be slipped off the drum shaft.

(5) An empty drum with the shaft and two cones weighs approximately 165 pounds. One with 1.7 miles of wire wound on weighs approximately 500 pounds.

f. To remount drum.—(1) Clean the cone-clutch leather faces and oil them lightly with neat's-foot oil. Clean the clutch seats in the drumheads and the bearings of the drum shaft.

(2) If the intermediate gear and intermediate pinion have been taken out, do all the work of reassembling them before replacing the drum.

(3) If the planks used to support the drum when inserting the drum shaft bolts overhang four or five feet to the rear, the resulting leverage will assist materially in getting the drum back into position.

(4) Put the drum shaft bolts back into the same sides from which removed. When tight, they will come right for the fillister head locking screws. Set the metal of the bolts or of the screws with a punch to secure them.

(5) Slush the teeth of the drum shaft pinion with grease, graphite, medium.

(6) Replace the clutch yokes, wire guide and bar, rear chest, and the wheels.

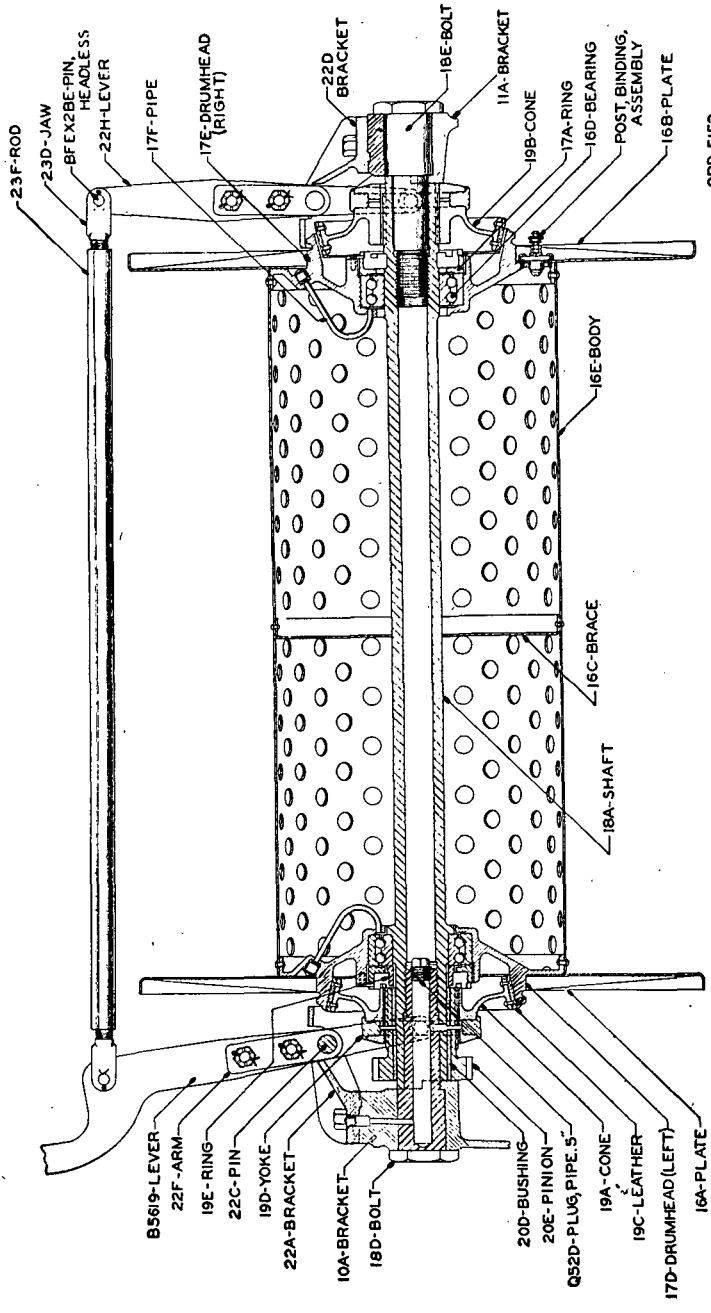


FIGURE 105.—Battery reel M1917A2, section through drum and clutches.

g. Instructions for assembling and disassembling of the wheels, wheel fastenings, pole, doubletree, singletrees, neck yoke, and padlocks and bolt snaps are contained in paragraph 93.

97. Artillery reel M1909MI.—*a. To dismount and replace outer chain guard.*—(1) Remove the right wheel.

(2) Remove the four bolts holding the chain guard. The guard is secured by two bolts to the supports on the side rail, one bolt to the bottom flange of the axle bracket, and one bolt to the forward web of the axle bracket. In a number of reels, this latter bolt has been assembled with the nut inside the axle bracket. This is awkward because of the limited space in which to manipulate the cotter pin. In replacing this bolt, put the nut outside of the axle bracket and the other bolts nut down. See that the guard clears the chain properly. If it rubs, loosen all the bolts, adjust the guard, and, if necessary, bend the supports to obtain clearance. Oil the threads before putting on the nuts and replace the cotter pins.

(3) The bolts in the original outer chain guard are $\frac{3}{8}$ by $2\frac{7}{16}$ inches (1) and $\frac{1}{2}$ by $1\frac{3}{16}$ inch (2) with crown nuts and cotter pins. For replacement use standard cap screws $\frac{3}{8}$–16NC–2 by $2\frac{1}{2}$ inches (1) and $\frac{1}{2}$–13NC–2 by $\frac{3}{4}$ inches (2) with slotted nuts and split cotter pins.

b. To dismount inner chain guard.—(1) The guard is attached by two bolts and by an eyebolt passing through the cross brace.

(2) The bolts in original inner chain guard are $\frac{1}{2}$ by $1\frac{3}{16}$ inch (1) and $\frac{1}{2}$ by $2\frac{9}{16}$ inches (1) with slotted nuts and cotter pins. For replacement use standard cap screws $\frac{1}{2}$–13NC–2 by $\frac{3}{4}$ inches (1) and $\frac{1}{2}$–13NC–2 by $2\frac{1}{2}$ inches (1) with slotted nuts and split cotter pins.

(3) Remove the front bolt or cap screw and the nut of the eyebolt, then work the guard forward, pulling the eyebolt out of the cross brace.

c. To dismount roller chains.—(1) Several types and makes of chains are in use. In the plain roller chain with side links all the links are riveted, except one assembling link which is secured by cotter pins on one side.

(2) Remove the cotter pins and disengage the link to remove the chain.

(3) Before reassembling, clean the chain by washing with solvent, dry-cleaning, and then immerse it in a hot solution of grease, graphite, medium. Leave it in this solution until it becomes as hot as the solution, otherwise the grease will not penetrate to the interior parts where it is most needed. After removing the chain from the solution, lay it on a level surface and push the links together to take up all the stretch, permitting the lubricant to become settled in the bearings.

(4) When the chain is cold, wipe it off well on the outside before placing it in service, this will prevent its gathering dust and grit. Replace the chain so that it runs in the same direction and with the same side out as it did originally.

d. To adjust tension of driving chains.—(1) The roller chains must be neither too tight nor too loose. The ideal tension allows about ½ inch sag in the upper line of the chain when the bottom line is drawn tight. Chains tighten up when they become dirty.

(2) To tighten, first loosen the nuts of the four jackshaft frame bolts and the lock nuts of the chain tightener. Unscrew the chain tightener. This forces the jackshaft forward. Continue until there is ½ inch sag in the loose line of the tighter chain.

(3) The bolts in original jackshaft frames are ½ by $2\frac{13}{16}$ inches (2) and ½ by $3\frac{25}{32}$ inches (2) with slotted nuts and cotter pins. For replacements use standard cap screws ½-13NC-2 by 2¾ inches (2) and ½-13NC-2 by 3¾ inches (2) with slotted nuts and split cotter pins.

(4) Set up the chain-tightener lock nut. Tighten up the nuts of the jackshaft frame bolts or cap screws and replace the cotter pins if in use. For convenience the two upper jackshaft bolts or screws may be assembled with the nuts on top.

e. To remove link of roller chain.—(1) When the chains wear until they are loose, after all possible tightening movement of the jackshaft has been accomplished, one-half link may be taken out of each chain. Note that by reason of the lapping of the side plates, the unit of a roller chain includes two rollers. Thus, if the chain is to have an odd number of rollers, the ends must be joined by an offset connecting link; that is, one in which the side plates outside one roller are offset to become the inside side plates for the next roller.

(2) When new, the longer inner chain is fitted with an offset connecting link. When the chains are to be shortened, this link must be transferred to the outer chain in place of one common link (two inner side plates with rollers) and one pair of outer side plates with pins.

(3) The chain repair block, consisting of the base, anvil, and set, is used for removing a riveted link of the chain. In using the chain repair block, the base is placed on a solid foundation and the anvil inserted through the chain opposite the side plate, which is to be removed. Place the anvil and the chain over the groove in the base and support the ends of the chain and anvil flush with the top of the base to secure even and full contact. Using a small hammer, strike

the top of each rivet in the side plate sharp but not heavy blows, driving the rivet back into the side plate. This shears off the riveted end of the rivet, which may then be punched out with the small pin in the set. Before reassembling, straighten the side plate if it is bent. Rerivet, using the base as an anvil, first driving the side plate down upon the shoulder of the rivet with a light blow on the set.

f. To dismount drums.—(1) Dismount the inner driving chain.

(2) Unscrew the four cap screws in the left axle bracket cap and remove the cap.

(3) Remove the two machine screws from the oiler clip on the right axle bracket cap and allow the oiler to swing out of the way.

(4) Take out the four cap screws in the right axle bracket cap and remove the cap, handwheel, and standard.

(5) Lift out the drums and shaft. The suggested method is a rope sling around each drum outside the intermediate drum end plates with a tackle block overhead, so arranged that a lift of at least 20 inches is secured.

g. To remount drums and drum axle.—(1) Clean the ends of the drum axle and seats in the axle brackets.

(2) Observe the close-fitting pins in the axle brackets which enter holes in the drum axle. Lower the drums carefully onto these pins and make sure there is no clamping action tending to bend the drum axle when the bolts are drawn tight.

h. To disassemble friction clutch (right drum).—(1) This operation is not to be undertaken by the battery personnel except under the direction of someone familiar with the clutch and the methods of reassembling.

(2) The drums being dismounted, remove the three drum clutch adjusting ring lock screws and locks. Unscrew the adjusting ring with the large spanner provided for this purpose. If force is required, be careful in clamping or holding the drum by the end plate so as not to deform it.

(3) Remove the drum clutch shifter bevel gear, unscrew it from the shifter, and slide off the drum sprocket ring and relief spring.

(4) Reach through the openings exposed in the drum friction disk and withdraw one cotter pin from each pin connecting the friction disk to the toggle links. Take out these toggle link pins and remove the friction disk.

(5) Take out the locking screw of the clutch spider filler ring, and unscrew the ring from the spider. Use a small drift or punch to turn the filler ring, being careful not to batter the threads. Pull the shifter toward the end of the axle as far as it will go by reassembling the

drum clutch shifter bevel gear. Then push the spider back, uncovering the sliding keys. Work the keys out by inserting a thin piece of metal between the ends of the semicircles. Note that they are assembled with a small rectangular projection toward the outer end of the slot.

(6) Pull out the shifter and the gear. Note the small ring inside the shifter into which the fingers of the sliding keys fit. If loose, be sure to replace when assembling.

i. The driving clutch being dismounted, the drum axle may be pulled out from the drums to the right. Whenever the friction clutch is dismounted, the opportunity to examine, clean, and slush the roller bearings should be taken advantage of. Note the loose ring between the drums so that it is not forgotten in assembling.

j. To assemble friction clutch.—(1) Assemble the drums properly on the drum axle. Clean all parts of the clutch thoroughly and oil them lightly. Extreme care should be taken that excess lubricant does not reach the friction facing of the clutch plates. Oil on the clutch facing will cause it to become glazed and result in ineffective clutching.

(2) Assemble the toggle links to the toggle brackets and radial links. Slip the drum clutch spider on the drum axle and connect it to the radial links.

(3) Place the ring to receive the fingers of the sliding keys in the drum clutch shifter, and insert the shifter in the axle. Slip the keys in place with the rectangular projection on each key toward the outer end of the axle slot. New keys should not drive too tightly because there will be trouble in removing them later on. Slip the spider over the keys and see that it turns freely. Oil the keys, assemble the drum clutch spider filler ring and drum clutch spider filler ring screw, and set the metal of the ring into the notches of the screw to lock it.

(4) Put one cotter pin in each of the pins which are to connect the outer toggle links to the drum friction disk, and put the pins into the links so that they hang from the outer ends of the radial links. Oil all the pins. Put on the friction disk and, reaching through the openings with the fingers of one hand, manipulate the toggle link pin to make the connection while the fingers of the other hand guide the links. Insert and open the cotter pins in the toggle link pins.

(5) Complete the assembling by putting in the drum clutch relief spring, drum sprocket ring, and the drum clutch adjusting ring. Adjust the tension of the driving chains as described in *d* above.

k. To dismount left drum clutch.—(1) It is not necessary to dismount the drums.

(2) The drum clutch rod guide is screwed into the left drumhead and locked with a driven pin in the threads. Drive or drill out the pin and unscrew the clutch rod guide. The drum clutch rod assembly will come out through the opening.

l. To dismount jackshaft.—(1) Take off the inner and outer chain guards and outer chain as described in *a*, *b*, and *c*, above.

(2) Unscrew the jackshaft nut. The metal of the shaft has been set with a punch into the four notches in the end of the thread. It may be necessary to clip this out. The inner chain will assist in holding the jackshaft while the nut is being unscrewed. The outer jackshaft sprocket will probably be tight on its tapered seat.

(3) Put a hardwood block against the outer end of the jackshaft and strike a sharp blow to loosen it. Do not lose the round-bottomed (Woodruff type) key. If the key sticks in the shaft, rock it out by driving down the outer end with a bronze drift.

(4) Take off the inner roller chain, loosen the bolts in the jackshaft frame and the chain tightener, and pull the jackshaft frame to the rear as far as possible. The jackshaft and sprocket can then be worked out.

(5) The bolts in original jackshaft frames are ½ by $2\frac{13}{16}$ inches (2) and ½ by $3\frac{25}{32}$ inches (2) with slotted nuts and cotter pins. For replacement use standard cap screws ½-13NC-2 by 2¾ inches (2) and ½-13NC-2 by 3¾ inches (2) with slotted nuts and split cotter pins.

(6) Clean out all the oil passages before reassembling. Do not attempt to dismount the jackshaft frame from the side rails.

m. To disassemble automatic pole supporting spring.—(1) The pole supporting spring cap is screwed into the pole supporting spring cap holder and locked with a headless screw. The pole supporting spring at assembled height is loaded at 2,060 pounds, but the length of thread of the cap is such that the spring is free, or nearly so, before the threads are disengaged.

(2) Unscrew the cap, using the wheel hub cap wrench. The spring and yoke may now be lifted out. The spring should be slushed well with grease, graphite, medium, before reassembling.

n. To adjust automatic pole support.—(1) In proper adjustment, the automatic pole support holds the pole constantly at a height of 29.25 inches without support from the harness when the reel and cart props are in traveling position. When inspection shows that the pole is not supported at the proper height, the cause should be determined and the necessary corrections made. Commonly the cause is—

(*a*) The pole is loose in the pole socket or is bent.

(*b*) The automatic pole support is not properly adjusted.

(2) To adjust the automatic pole support—

(*a*) Clamp the pole properly in the pole socket.

(*b*) Clean and lubricate all parts and see that they move freely.

(*c*) Adjust the compression of the pole supporting spring to support a 20-pound weight suspended from the pole at the neck yoke stop.

(*d*) The pole supporting spring is compressed by moving the locking screw and, using the wheel hub cap wrench, screwing down the pole supporting spring cap.

(3) If the pole still droops, it is likely that the lug of the pintle or the bottom of the lunette, or both, are worn. If this is the case, place shims between the lug of the pintle and the lunette as described in paragraph 94*c*(3).

(4) The method of adjusting the automatic pole support when the vehicle is equipped with the modified pintle is to adjust the height of the pole to approximately 29½ inches by adding shims (three are furnished with each modified pintle), if necessary, under the head of the adjusting bolt. Measure from a level floor to the center of the pole when the vehicle is limbered with another vehicle.

o. To dismount pintle.—(1) Disassemble the pole supporting spring and spring yoke. The front end of the pintle shank will rise, exposing the pintle nut and cotter pin. Pull out the cotter pin.

(2) Tip the pintle shank horizontal again and put the small end of the wheel hub cap wrench between the flats of the pintle nut and the sides of the pintle bearing seat and turn the pintle to unscrew the nut. When free, the pintle will come out to the rear; the pintle nut, pintle bearing spring, and sleeve to the front.

(3) Slush the pintle bearing spring with grease, graphite, medium, before reassembling.

p. To dismount pintle bearing.—(1) Disassemble the pole supporting spring and spring yoke.

(2) Disconnect the foot lever from its bracket and the left end of the brake rod to get the rod out of the way, and take off the rear cross rail (handhole) covers. Working through the opening for the pole supporting spring, find and extract the cotter pins of the pintle bearing trunnion bolts.

(3) Using the 1¼-inch opening of the engineer's wrench as a socket wrench, work through the handholes to start the pintle bearing trunnion bolts. Once started, they may be unscrewed by hand. Replace the cotter pins in reassembling. These cotter pins need not be crimped open but merely spread a little before assembling.

q. To dismount axle sprocket.—(1) The holes for the pins of the driving ring in the axle sprocket are covered on the inside with thin plates secured by bolts.

(2) Remove a bolt from one end of one axle-sprocket hub cover plate and swing the plate around so the axle-sprocket retainer bolts may be removed through the hole for the driving ring pin.

(3) Remove the six axle-sprocket retainer bolts and pull the sprocket from its seat.

(4) A space between the axle-sprocket hub and its bushing is used for oil storage. Before assembling, clean all oil holes and smooth any roughness of bushing, sprocket retainer, or seat on the axle sprocket.

r. Instructions for assembling and disassembling of the wheels, wheel fastenings, pole, doubletree, singletrees, neck yoke, and padlocks and bolt snaps are contained in paragraph 93.

98. Artillery cart M1918A1.—*a.* Disassembling operations for the brake mechanism, carrying springs, and pintle are similar to those outlined in assembling and disassembling instructions for the 75-mm gun caisson M1918 in paragraph 94.

b. Instructions for disassembling and assembling of the wheels, wheel fastenings, pintle latch and spring, lunette, and padlocks and bolt snaps are contained in paragraph 93.

SECTION VI

CARE AND PRESERVATION

	Paragraph
Inspection of all vehicles	99
General care of all vehicles	100
Cleaning	101
Lubricating instructions	102
Special maintenance of 75-mm gun caisson and gun carriage limber M1918	103
Special maintenance of 75-mm gun caisson M1918	104
Special maintenance of battery reel M1917A2	105
Special maintenance of artillery reel M1909MI	106
Special maintenance of artillery cart M1918A1	107

99. Inspection of all vehicles.—*a.* Daily inspection should be made to discover any parts which need attention or adjustment.

(1) See that the vehicles are clean and properly lubricated.

(2) Operate and examine the brake mechanisms to see that they function properly.

(3) Examine hinges, straps, fasteners, chest packings, etc., to see that they are in serviceable condition.

(4) Check the accessories to see that they are in their proper place and that none are missing.

b. At least once a month the vehicles should be inspected thoroughly by the battery mechanics under the direction of the commanding officer. Follow the instructions given above, and in addition—

(1) Operate all moving parts to see that they work freely and function properly.

(2) Examine all nuts and bolts to see that they are tight and that cotter pins are in place in slotted nuts. In making replacements, when practicable use cap screws with slotted nuts and split cotter pins.

(3) Examine for loose and broken rivets.

(4) See that there is no excessive end play of wheels on the axles.

(5) Examine the condition of the paint.

100. General care of all vehicles.—*a.* The vehicles cannot be kept in serviceable condition unless proper attention is given to cleaning, lubrication, and to loose and broken parts. Lubrication is taken up in detail in paragraph 102.

b. All bearing surfaces, screw threads, and exterior parts must be kept as clean as possible. Special attention should be given to bearing surfaces. Extra precautions must be taken during disassembling and assembling operations to prevent the entrance of foreign matter into the working parts.

c. Maintenance of wheels and wheel fastenings.—(1) Wheels and wheel fastenings should be dismounted periodically and the fastenings, hub boxes, axle arms, and axle bores cleaned and examined. Roughness due to cutting or scoring should be removed. When the wheel fastening wears $\frac{1}{16}$ inch, it should be turned around. When both sides have worn $\frac{1}{16}$ inch, it no longer should be used.

(2) The dust guards should be examined to see that they are in serviceable condition. If the wool is matted with grease and dirt it should be washed with solvent, dry-cleaning.

(3) Nuts on the hub bolts should be tightened monthly during the first year of service and twice a year thereafter. The ends of the bolts should be peened over slightly to prevent the nuts from unscrewing.

(4) When the hub bolts are tightened, the hub band should be screwed up as tightly as possible against the lock washer.

(5) Although the spokes and fellies of the wheels are made of thoroughly seasoned wood, it will be found that tires and spokes become loose due to shrinkage. A wheel with a loose tire or spoke will become unserviceable rapidly if the trouble is not remedied. Keeping the hub bolts tight at all times will eliminate much of this trouble.

(6) Soaking of wheels in water to tighten spokes and fellies is forbidden.

(7) Wheels should be kept well painted at all times. This prevents moisture from rotting the wood and also prevents water from getting into the wood and swelling it.

d. Maintenance of poles.—Keep poles tight in the pole sockets. Maintenance of the poles by the battery will be limited to replacement of the counterstop or counterstop spring, cleaning, and painting. A badly kinked or bent pole should be sent to ordnance personnel for repair.

e. Maintenance of doubletrees.—Maintenance of the doubletrees consists of cleaning, painting, and the replacement of a doubletree bolt or nut, doubletree hook, or a nipple separator when necessary.

f. Maintenance of singletrees and neck yokes.—Maintenance of the singletrees and neck yokes consists of replacing a singletree hook, cleaning, and painting. It may sometimes be necessary to straighten a singletree or neck yoke, but in doing so neither should be heated.

g. Maintenance of lunettes.—It may sometimes be necessary to replace a damaged or worn lunette. Otherwise the maintenance of lunettes will consist in keeping them tightly seated and free from rust.

h. Maintenance of pintles and pintle latches.—Pintles and pintle latches should be kept clean. The pintle should rotate freely 360° in the pintle bearing. The pintle latch should function without forcing. The parts most liable to damage are the pintle latch and the pintle latch spring.

i. Maintenance of padlocks.—If padlocks do not unlock freely, they should be washed with solvent, dry-cleaning. Do not use oil on padlocks, as it gathers dirt.

101. Cleaning.—*a.* The vehicles should be thoroughly cleaned and lubricated at intervals not exceeding one month. Care should be taken to keep all parts free from rust. All bearing surfaces must be kept clean at all times. Only those cleaning materials issued should be used.

b. In cleaning disassembled parts, wash with water or dry-cleaning solvent, dry thoroughly, then oil lightly.

c. To clean off rust-preventive compound, the greater part should be scraped off, the balance removed by using rags or cotton waste dipped in dry-cleaning solvent. A hot solution of lye and water will also loosen the compound and render it easy to remove.

d. Dry-cleaning solvent will be found useful in cutting and loosening any oil which has become dry and gummy.

e. Rust may be softened by using dry-cleaning solvent and scraping with a piece of wood.

f. Oil holes which have become clogged should be opened up with a piece of wire. Wood should never be used for this purpose, as splinters are likely to break off and clog the passages.

102. Lubricating instructions.—*a.* The life of the vehicle depends to a great extent upon proper lubrication. Particular attention should be given to sliding and bearing surfaces. Oil cups, oil holes, openings, or exposed surfaces provide means for lubricating the various bearing parts.

b. Grit must be kept out of the lubricant and lubricating openings. In cleaning oil cups and open oil holes, the necessary wiping should be done with a piece of firm cloth and no lint should be allowed to remain in any orifice. Open oil holes which have become clogged with congealed oil should be cleaned with a piece of wire. Never use wood for this purpose, as splinters are apt to break off and clog the passages.

c. Parts should be manipulated while the lubricant is being applied, to insure distribution of the lubricant to all moving parts.

d. Care must be taken when cleaning oil and grease compartments to insure complete removal of all residue or sediment and to prevent dirt or other foreign matter from entering the compartments.

e. Should an oiler valve stick in its seat and prevent passage of oil, it can be loosened by a piece of wire pushed through the hole. Take care not to damage the valve.

f. The following oiling and greasing chart is based on the probable lubrication required for vehicles in continual service. It should be used as a general guide only, as the requirements will vary according to conditions.

LUBRICATION CHART

75-mm gun caisson and carriage limbers M1918

Part	Method	Lubricant	Remarks
Hub cap	Oiler (2)	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	⅛ pint per day or every 25 miles.
Doubletree bolt	On bearing surfaces.	do	Few drops once per day.
Trunnion bolts	Oil cup in each trunnion bolt (2).	do	Few drops once per week.
Pintle	Fill pintle spring chamber.	Grease, O. D., No. 1.	When assembling.

75-mm gun caisson and carriage limbers M1918—Continued

Part	Method	Lubricant	Remarks
Pin, headless	On bearing surfaces.	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per week.
Lock bar	At hinge joints (2).	do	Do.
Door hinge, male	At hinge joints (4).	do	Do.
Door hinge, female			

75-mm gun caisson M1918

Part	Method	Lubricant	Remarks
Lock bar	At hinge joints (2).	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per week.
Apron latch base, left.	At contact surfaces.	do	Do.
Apron latch base, right.			
Fuze setter anchor rod bearing.	At contact surfaces (2).	do	Do.
Pintle bearing	Oil cup	do	Do.
Hub cap	Oiler (2)	do	⅛ pint per day or every 25 miles.
Brake lever shaft	Bearing surface of shaft.	do	Few drops once per week.
Apron hinge	At hinge joints (4).	do	Do.
Door hinge, female	do	do	Do.
Door hinge, male	do	do	Do.
Pintle latch	Bearing surface at pintle latch pin.	do	Do.
Side rail liner, right	At contact surfaces (4).	do	Do.
Brake band pin for adjusting link.	Bearing surface of pin (2).	do	Do.
Brake band pin for brake band.	Bearing surface of pin (4).	do	Do.
Prop fastening pin	Bearing surface of pin.	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Do.
Apron latch plunger	Bearing surface of plunger (4).	do	Do.

75-mm gun caisson M1918—Continued

Part	Method	Lubricant	Remarks
Door prop stud	Bearing surface of stud.	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per week.
Brake hanger, left	Oil cup	do	Do.
Brake hanger, right	do	do	Do.
Brake rod	Bearing surface of pin (2).	do	Do.

Battery reel M1917A2

Part	Method	Lubricant	Remarks
Hub cap	Oiler (2)	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	⅛ pint per day or every 25 miles.
Axle bracket, right	Oil cup	do	Few drops once per day.
Axle bracket, left	do	do	Do.
Hand lever bracket	do	do	Do.
Clutch yoke	At contact surfaces (2).	do	Do.
Drumhead, left	Oil cup	do	Few drops once per month.
Drumhead, right	do	do	Do.
Hand lever pin	On bearing surfaces (2).	do	Few drops once per week.
Roller stud (carrying).	Oil cup (2)	do	Do.
Spring, lower (carrying).	Slush (4) each	(Grease, graphite, medium.)	When assembling.
Spring, upper hasp, for rear chest.	At hinge joints (3)	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per week.
Hasp, for front chest	At hinge joints (2)	do	Do.
Front chest door hinge, female.	At hinge joints (4) each.	do	Do.
Front chest door hinge, male.			
Lid hinge, female	At hinge joints (3) each.	do	Do.
Doubletree bolt	On bearing surfaces	do	Do.

Artillery reel M1909MI

Part	Method	Lubricant	Remarks
Hub cap	Oiler (2)	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32°F.	⅛ pint per day or every 25 miles.
Handwheel assembly	Oil cup	do	Fill once per day.
Drum axle oiler assembly.	Oiler	do	Do.
Drumhead, left	Oil cup	do	Few drops once per day.
Axle bracket cap, right.	Oiler (2)	do	Fill once per day.
Axle bracket cap, left.	do	do	Do.
Drum clutch rod	On sliding surface.	do	Few drops once per week.
Axle sprocket	Oil hole	do	Few drops every 5 miles.
Jackshaft	Oil plug	Grease, O. D., No. 1.	Fill once per day or every 25 miles.
Jackshaft frame	Oil cup	Oil, engine, SAE 30 below 32°F. and SAE 50 above 32°F.	Few drops every 5 miles.
Roller chain, ¾ inch pitch, ⅜ inch wide, 69¾ inches long.	Clean with brush and lubricate.	Grease, graphite, medium.	As required.
Roller chain ¾ inch pitch, ⅜ inch wide, 67½ inches long.	do	do	Do.
Pole-supporting spring cap.	Oil cup	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per day or every 25 miles.
Pintle bearing	do	do	Do.
Pintle latch pin	On bearing surfaces.	do	Few drops once per week.
Pintle bearing spring	Slush	Grease, graphite, medium.	When assembling.
Pole-supporting spring.	do	do	Do.
Rear roller bracket, right.	Oil holes	Oil, engine, SAE 30 below 32° F. and SAE 50 above 32° F.	Few drops once per week.
Rear roller bracket, left.	do	do	Do.

Artillery reel M1909MI—Continued

Part	Method	Lubricant	Remarks
Doubletree bolt, assembly (when horse-drawn).	On bearing surfaces.	Oil, engine, SAE 30 flelow 32° F. and SAE 50 above 32° F.	Few drops once per day.
Tool chest hinge, female.	At hinge joints (2).	----do----	Few drops once per week.
Tool chest hinge, male.			

Artillery cart M1918A1

Part	Method	Lubricant	Remarks
Hub cap----	Oiler (2)----	Oil, engine, SAE 30 below 32°F. and SAE 50 above 32°F.	⅛ pint per day or every 25 miles.
Side rail liner, left---	At contact surfaces (4).	----do----	Few drops once per day or every 25 miles.
Side rail liner, right.-	----do----	----do----	Do.
Carrying spring----	Slush (4)----	Grease, graphite, medium.	When assembling.
Brake hanger, left---	Oil cup----	Oil, engine, SAE 30 below 32°F. and SAE 50 above 32°F.	Few drops once per week.
Brake hanger, right--	----do----	----do----	Do.
Brake band pin for brake band..	At contact surfaces (4).	----do----	Do.
Brake band pin for adjusting link.	At contact surfaces (2).	----do----	Do.
Shield hinge, female-	At hinge joints (4) each.	----do----	Do.
Shield hinge, male---			
Lock bar A, rear----	At hinge joints--	----do----	Do.

103. Special maintenance of 75-mm gun caisson and gun carriage limber M1918.—Maintenance of the limber chests consists mainly in oiling the hinges and locking devices and cleaning. Occasionally a handrail is bent or an implement strap broken. Replacement of such parts is so simple that specific instructions are unnecessary.

104. Special maintenance of 75-mm gun caisson M1918.—*a.* Maintenance of the caissons consists mainly of lubrication and cleaning. Occasionally a handrail is bent or an implement fastening or strap is broken. Replacement of such parts is so simple that specific instructions are unnecessary. Due to a difference in radii of ogives of certain shells, there is a tendency of the projectiles to rattle and occasionally to break loose from their cartridge cases in the rear diaphragm. In the event of a projectile of any kind becoming stuck in the caisson, refer to ordnance maintenance personnel for removal.

b. Maintenance of the hand reel M1917.—(1) The bolts or cap screws, whichever may be in use, that attach the reel to the caisson may become loose or sheared off. Tighten them or insert new cap screws. It is not necessary to take out any of the ammunition chest connecting pieces to do this.

(2) The chains of the bearing pins and cranks are sometimes broken off. Spare chains may be attached by connecting the replacement to the chain rivet.

c. Maintenance of the brake mechanism.—Brake levers must not be released by a kick or blow. When brake bands slip and fail to lock the wheels, they may be worn or merely greasy. Wash the lining surfaces thoroughly with solvent, dry-cleaning, and adjust. No dressing of any kind is to be put on the linings. When linings are worn beyond further service, which will be when no further adjustment is practicable or when the copper rivets attaching them to the bands become loose, an entire brake band assembly may be acquired and installed. Refer any other brake mechanism trouble to the maintenance company for correction.

d. To adjust the brake bands.—The braking effect should be the same for both wheels. It should be possible to skid the wheels and to secure proper release of the brake bands when the brake lever is operated. When the linings become badly worn, jack up the axle to raise one wheel, disconnect the adjusting nut from the brake band end, and tighten the nut on the adjusting link an estimated number of turns for correct adjustment. Reconnect the adjusting link to the band and set the brake. It should hold the wheel when a man of ordinary weight stands on the outer end of one of the horizontal spokes. Then throw the brake lever to the extreme released position and note whether the brake band drags when the wheel is turned. If it does, the band is too tight and must be readjusted. The brake lever should not come to the last notch in the segment when the brake is set. Leave a little movement in reserve for wear of the lining. Follow the same procedure with the other wheel.

105. Special maintenance of battery reel M1917A2.—*a.* Maintenance of the battery reel consists mainly of lubrication and cleaning. Occasionally, handrails are bent and straps, strap fasteners, or padlock chains are broken. It is necessary at times to replace a pole socket bolt, a drum key, clutch cones, cone leathers, or rear chest carrying springs. Replacement of these parts is so simple that specific instructions other than those outlined for disassembling and assembling in paragraph 98 are unnecessary.

b. The leather of the cones should be inspected at least once every 3 months. Apply neat's-foot oil to the leather to soften and preserve it.

c. Tighten loose bolts or cap screws.

106. Special maintenance of artillery reel M1909MI.—*a.* Maintenance of the artillery reel consists mainly of minor adjustments, lubrication, and cleaning.

b. The reel driving chains should be dismounted once a month, thoroughly cleaned, washed in dry-cleaning solvent, and then dipped in a hot solution of medium graphite grease, making certain that the lubricant penetrates every bearing.

c. Drum and sprocket bearings should be cleaned and flushed out with dry-cleaning solvent monthly. Block up the axle so it is horizontal and the right wheel is off the ground. Fill all the oil holes and passages with dry-cleaning solvent, turn the right wheel and refill until the dry-cleaning solvent flushes through the bearings. Give the wheel several turns, allow to drain, and then lubricate as indicated in the lubricating chart, paragraph 102.

d. Serious deformation of the frame, braces, drums, clutch, clutch standard, driving chains, and loose or broken rivets should be referred to ordnance personnel for correction.

e. Tighten loose bolts and cap screws.

107. Special maintenance of artillery cart M1918A1.—*a.* Maintenance of the cart consists mainly of lubrication, cleaning, and care of the packing in the interior of the chest. Occasionally handrails are bent or straps or fasteners are broken. Replacement of such parts is so simple that specific instructions are unnecessary.

b. Pads, cushions, and spring supports for the delicate instruments carried in the chest should be inspected frequently. They should be kept in a serviceable condition at all times.

c. Maintenance and adjustment of the brake mechanism are discussed in paragraph 104*c* and *d*.

CHAPTER 6

ORGANIZATION SPARE PARTS AND ACCESSORIES

Paragraph
Organization spare parts 108
Accessories 109
Accessories for gun and gun carriage 110
Accessories for gun caisson and limbers 111

108. Organization spare parts.—*a.* A set of organization spare parts is supplied to the using arm for field replacement of those parts most likely to become broken, worn, or otherwise unserviceable. The set is kept complete by requisitioning new parts for those used. Organization spare parts are listed in pertinent SNL's.

b. Parts should be kept clean and lightly oiled to prevent rust.

109. Accessories.—*a.* Accessories include tools and equipment required for such disassembling and assembling as the using arm is authorized to perform, and for the cleaning and preservation of the gun carriage, sighting and fire-control equipment, ammunition, etc. They also include chests, covers, tool rolls, and other items necessary to protect the matériel when it is not in use, or when traveling. Accessories should not be used for purposes other than those prescribed, and when not in use should be properly stored.

b. There are a number of accessories whose names or general characteristics indicate their use. Others embodying special features or having special uses are described below.

110. Accessories for gun and gun carriage.—*a. Artillery gun book.*—The gun book (O. O. Form No. 5825) is used for the purpose of keeping an accurate record of the matériel. It must always remain with the matériel regardless of where it may be sent, and should be in the possession of the organization at all times. The battery commander is solely responsible for its custody and for the completeness of the records. The book is divided into record of assignments, battery commander's daily gun record, inspector's record of examination, as well as forms to be filled out in case of premature explosions. It must also contain data of issuance of the matériel, to and by whom issued, and place where issued. If a new gun is installed on the carriage, all data in the old book with reference to sights, carriage, etc., must be copied into the new gun book before the old book is relinquished.

Caution: Record of assignment data must be removed and destroyed prior to entering combat.

b. Bore brush and staff.—The bore brush and staff are for the purpose of swabbing and cleaning the bore of the gun. There is a "stop" provided on the staff which is used with rags or waste for slushing, oiling, or greasing the bore.

c. Chests.—Chests vary in sizes according to use. They may be of wood or steel. They are provided for storage and protection of equipment, cleaning material and small stores, and miscellaneous spare parts.

d. Covers.—Covers are provided for the gun, carriage, and accessories when necessary; also for certain items of fire-control and sighting equipment. These covers are usually made of olive-drab cotton duck and are used for the protection of the matériel when not in use. Cover, gun, M88 (M208 and M306) is standard for 75-mm gun carriage, M2A3; cover, M80 (M205 and M306) is standard for 75-mm gun carriages M2A1 and M2A2.

e. Equilibrator assembling nut.—This is an elongated hexagon nut which is used to retain the equilibrator in an assembled unit while removing or replacing the equilibrator. This applies to the 75-mm gun carriages M2A1, M2A2, and M2A3 only.

f. Filling and drain valve release.—This release has a long shank which opens the filling and drain valve to allow the reserve oil to drain from the recoil mechanism.

g. Fuze wrench.—There are two fuze wrenches used with this matériel. Fuze wrench M1 is used to set the older noncontoured type of fuzes Mk. III, Mk. IIIA, M35, M46, and M47. Fuze wrench M7 is used to set the contour type of fuzes M48 and M54.

h. Handspike.—The handspike is used in traversing the gun by moving the carriage trail. It also fits into the ratchet housing of the firing jack of M2A1, M2A2, and M2A3 carriages.

i. Lanyard.—The lanyard is composed of a certain length of sash cord with a handle at one end and a means of attachment to the firing mechanism at the other. It is used for firing the gun.

j. Lubricating gun and hose.—The grease gun is of the screw type. It forces the lubricant through a hose attached to the nozzle. The gun is filled by hand, the handle being unscrewed to its maximum out position with screw cover removed. After filling, the screw cover is replaced and the gun is ready for use. The end of the hose is fitted with a pull-on coupling which fits on the button-head type fittings of the carriage.

k. Oil gun.—A plunger type gun used to force oil into the desired bearings. It has a tapered nozzle to fit the oilers.

l. Oil screw filler.—The oil screw filler is a high pressure hand pump used to replenish the recoil mechanism with oil. The oil is forced through the nozzle by means of a screw plunger. The oil screw filler is screwed into the filling hole by an adapter placed over the hexagon portion of the filler body. Extreme care should be used in order that the threaded nozzle of the filler is not broken or the threads distorted. The handle should be centered and both hands used in order to assure an even stroke.

m. Powder temperature indicator M1 for 75-mm fixed rounds.—This is a dummy round used for measuring temperature of the ammunition. It consists of a standard 75-mm cartridge case containing a charge of material having the same thermal conductivity as powder and a 75-mm slug containing a dial type thermometer. It is packed in a fiber container having a wide band of white adhesive around it to distinguish it from containers for service rounds.

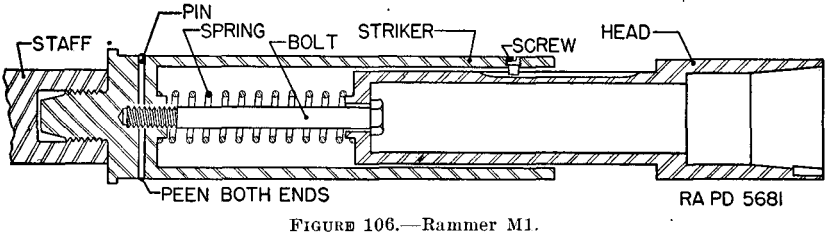


FIGURE 106.—Rammer M1.

n. Rammer M1 (fig. 106).—This device is used for removing live projectiles from the bore. It fits on the same staff as the sponge. The rammer should be used only under the direct supervision of an officer.

o. Sponge and staff.—The sponge and staff are for swabbing and cleaning the bore of the gun. The sponge is a piece of carpet mounted on a cylindrical wooden block which slips over a bronze head. The staff is attached to the head by a coupling.

p. Tire pump and tire gage.—The tire pump and tire gage are commercial types used respectively to inflate and to test the air pressure within the tire.

111. Accessories for gun caisson and limbers.—Accessories include ax, dust guard, pick mattock, paulin, hand reel, shovel, hatchet, oil can, picket rope, straps, pole prop, and fuze chests. Their nature and application are obvious.

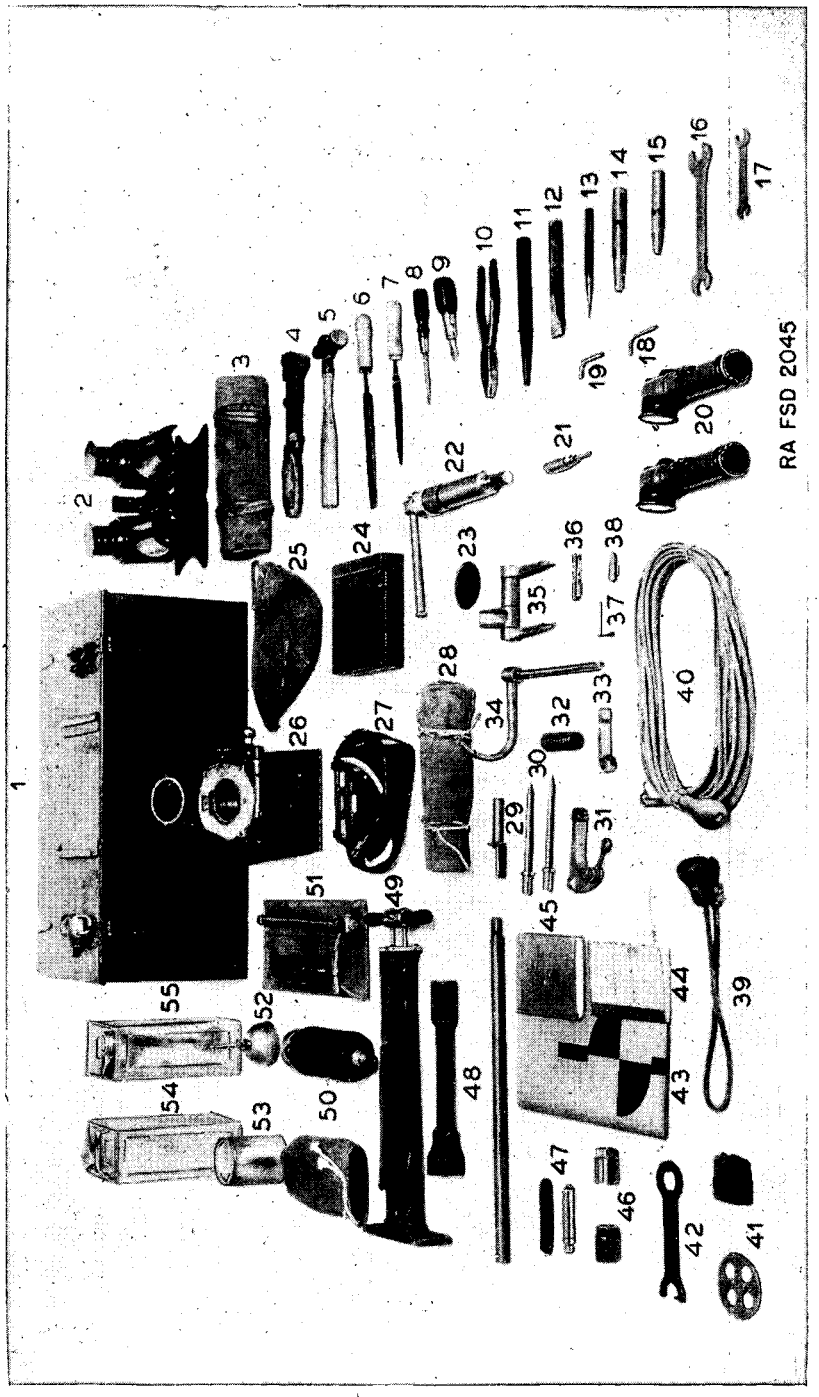


FIGURE 107.—Gun section chest for 75-mm gun carriage M2A1, M2A2, or M2A3.

Number	Item
1	Chest, gun section, M7.
2	Aiming post lamps (2).
3	Tool roll M4, with contents as follows:
4	Wrench, screw, adjustable, knife-handled, 12-inch.
5	Hammer, machinist's, ball peen, 20-ounce.
6	File, A. S., hand, second cut, 8-inch, with handle 1¼ by 4¼ inches.
7	File, A. S., three-square, smooth, 6-inch, with handle 1⅛ by 4 inches.
8	Screw driver, common, normal duty, 3-inch blade.
9	Screw driver, machinist's extra heavy duty, wood insert handle, 5-inch blade.
10	Pliers, side cutting, flat nose, 8-inch.
11	Punch, drift, ¼-inch point, 10 inches long.
12	Chisel, machinist's, hand, cold, ¾-inch.
13	Punch, drive pin, standard, ⅛-inch point.
14	Drift, brass, taper, ½-inch point.
15	Drift, brass, taper, 5/16-inch point.
16	Wrench, engineer's, double-head, alloy steel, 5/8 and ¾.
17	Wrench, engineer's, double-head, alloy steel, 7/16 and ½.
18	Wrench, socket head setscrew, 3/32-inch, hexagonal.
19	Wrench, socket head setscrew, ⅛-inch, hexagonal.
20	Flashlight, type TL95 (Signal Corps) (2).
21	Release, filling and drain valve.
22	Filler, oil screw.
23	Lens, green, for aiming post lamp.
24	Chest, gunner's quadrant, M1.
25	Cover, bracket fuze setter.
26	Setter, fuze, bracket, M1916, with anchor.
27	Quadrant, gunner's, M1, with carrying case.
28	Roll, spare parts, with contents as follows:
29	Rack, firing, assembly.
30	Pins, firing (2).
31	Hammer, firing, assembly.
32	Spring, firing rack.
33	Latch, breechblock, assembly.
34	Spindle, extractor.
35	Extractor.
36	Bolt, safety, assembly.
37	Pin, breechblock latch.
38	Pin, firing hammer.
39	Lanyard, assembly.
40	Lanyard, 50-foot.
41	Sight, bore, complete.
42	Wrench, fuze, M1.
43	Target, testing, paper (set of 4).
44	Book, artillery, gun, O.O. Form 5825 (blank).
45	Table, firing, 75–B–3.
46	Nut, assembling, equilibrator (2).
47	Gage, tire pressure, balloon, with case.
48	Wrench socket, for wheel stud nut, with handle.
49	Pump, tire, 2-cylinder, with hose.
50	Sponge M9, with cover.
51	Gun, lubricating, pressure, screw handle type, 8-ounce, with cover and heavy duty lubricating hose, 15-inch, buttonhead type.
52	Oiler, S., copper-plated, ⅛-pint, 3-inch spout.
53	Grease, O. D., No. 0 or No. 00.
54	Oil, engine, SAE 10 or 30.
55	Oil, recoil, heavy, low-pour point, gallon.
	Brush, bore cleaning (not shown).
	Screw driver, close quarter, 1½-inch blade (not shown).

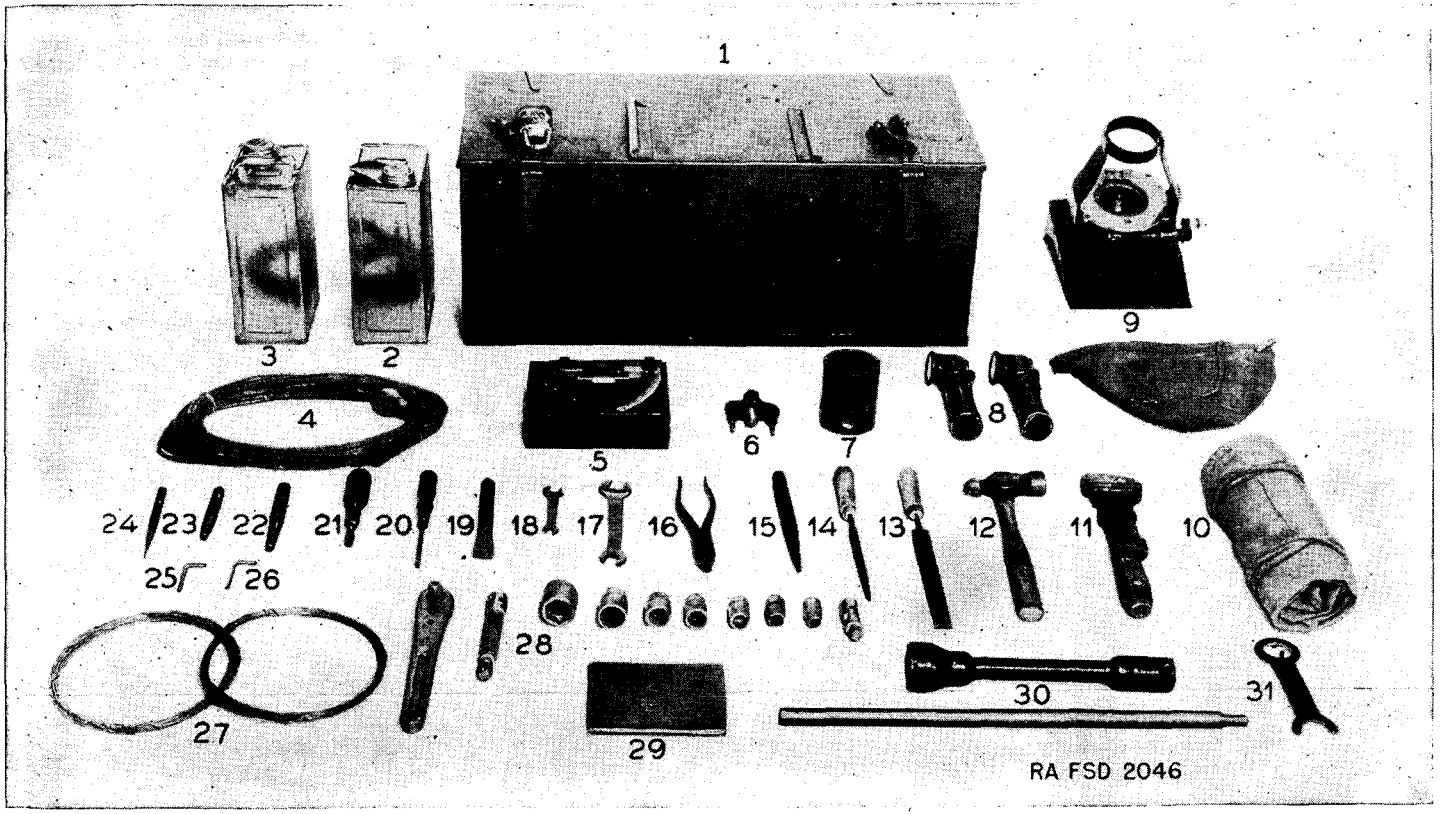


FIGURE 108.—Maintenance section chest, complete, for 75-mm gun carriage M2A1, M2A2, or M2A3.

Number	Item
1	Chest, gun section, M7.
2	Oil, recoil, heavy, low pour point, gallon.
3	Oil, engine, SAE 10 or 30.
4	Lanyard, 50-foot.
5	Quadrant, gunner's, M1, with chest (spare).
6	Puller, gear.
7	Wrench, socket.
8	Flashlight, type TL95 (Signal Corps) (2).
9	Setter, fuze, bracket, M1916, with anchor, with cover.
10	Tool roll M4, with contents as follows:
11	Wrench, screw, adjustable, knife-handled, 12-inch.
12	Hammer, machinist's, ball peen, 20-ounce.
13	File, A. S., hand, second cut, 8-inch, with handle 1¼ by 4¼ inches.
14	File, A. S., three-square, smooth, 6-inch, with handle 1⅛ by 4 inches.
15	Punch, drift, ¼-inch point, 10 inches long.
16	Pliers, side cutting, flat nose, 8-inch.
17	Wrench, engineer's, double-headed, alloy steel, ⅝ and ¾.
18	Wrench, engineer's, double-headed, alloy steel, 7/16 and ½.
19	Chisel, machinist's, hand, cold, ¾-inch.
20	Screw driver, common, normal duty, 3-inch blade.
21	Screw driver, machinist's, extra heavy duty, wood insert handle, 5-inch blade.
22	Drift, brass, taper, ½-inch point.
23	Drift, brass, taper, 7/16-inch point.
24	Punch, drive pin, standard, ⅛-inch point by 4 inches long.
25	Wrench, socket head setscrew, ⅛-inch, hexagonal.
26	Wrench, socket head setscrew, 3/32-inch, hexagonal.
27	Wire, copper, soft, 0.032-inch diameter, pound (2).
28	Wrench-set, socket, hexagonal openings, complete, with 1 ratchet, 10-inch; 1 grip, handy, 6-inch; 7 sockets, heavy duty, 1 each, sizes 7/16, 9/16, ⅝, ¾, 13/16, 1, and 1⅛; and 1 universal joint.
29	Table, firing.
30	Wrench, socket, for wheel stud nut, with handle.
31	Wrench, fuze, M1 (spare).

CHAPTER 7

SUBCALIBER EQUIPMENT

	Paragraph
Purpose	112
Description of breechblock and breech mechanism	113
Description of recoil mechanism	114
Breech mechanism	115
Gun and cradle disassembly and assembly	116
Inspection	117
Malfunctions	118
Care and preservation	119
Precautions	120
Practices to be avoided	121
Lubricating instructions	122
Gun mounts	123
Bore sighting	124
Miscellaneous operations	125
Spare parts and accessories	126
Ammunition	127

112. Purpose.—Subcaliber equipment, which is used for training purposes only and is not taken into the theater of operations, consists of the 37-mm subcaliber gun M1916, subcaliber mount M2, M7, or M8, and accessories. It is used to provide practice in laying and firing the 75-mm matériel. The use of smaller bore ammunition prevents wear on the regular piece during practice and is less costly. The actual handling, loading, and range obtained are different. The 37-mm subcaliber mount M7 is used on 75-mm gun carriages M2, M2A1, M2A2, and M2A3. The 37-mm subcaliber mount M8 is used on 75-mm gun carriages M1897MIA2 and M1897A4. The 37-mm subcaliber mount M2 is used on 75-mm gun carriage M1897 only.

113. Description of breechblock and breech mechanism.—*a. General.*—The breechblock is the Nordenfeld type somewhat similar (except in size) to that of the 75-mm guns listed above (fig. 109). The breechblock screws into the breech ring and rotates through an angle of 156° about its axis. The axis of the breech recess is below the axis of the bore. The breechblock is operated by the breechblock lever which, when moved to the left, causes the breechblock to rotate, thus carrying the eccentric part to a position in line with the bore, and also operates the extractor which extracts and ejects the cartridge case. The breechblock closes by moving the lever to the right, which places the firing pin in line with the percussion cap in the base of the cartridge case, and releases the safety bolt.

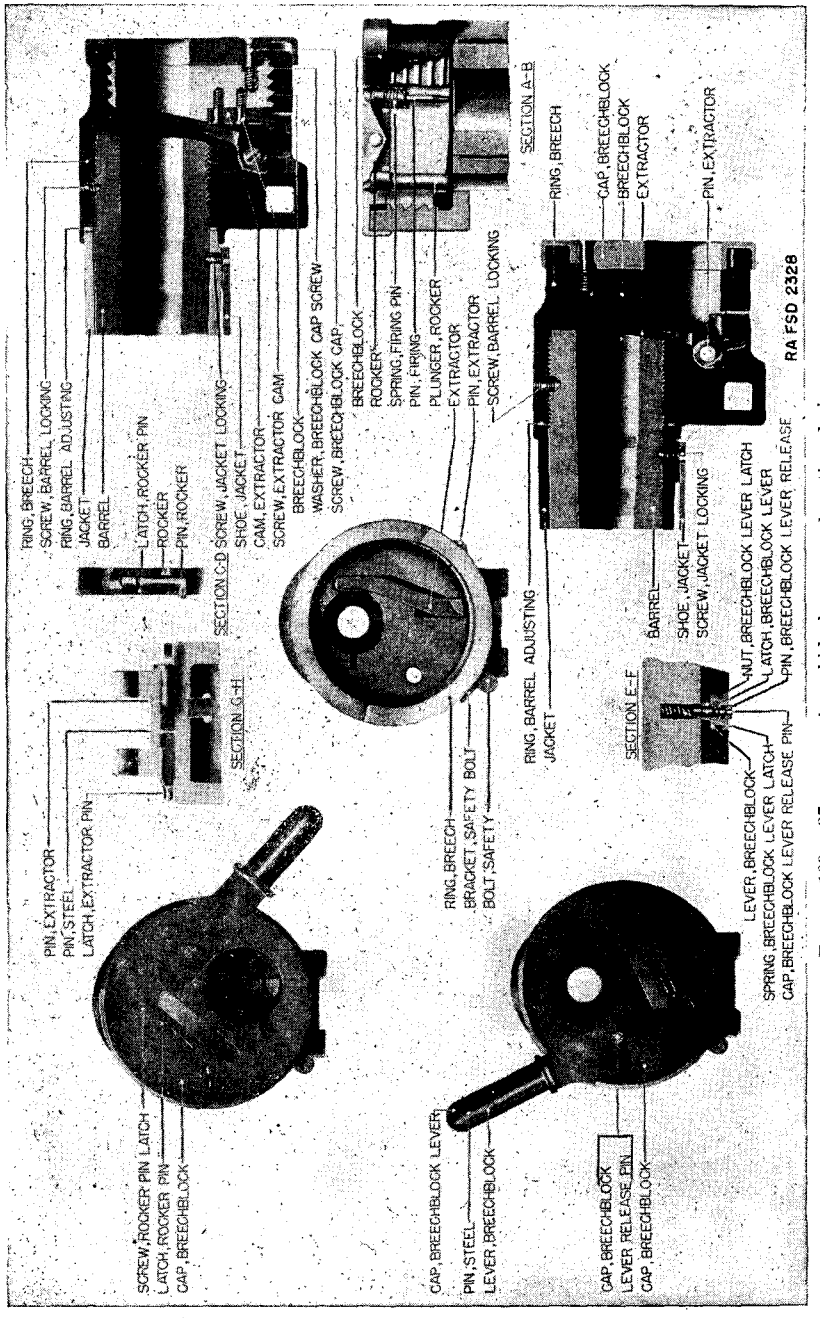


FIGURE 109.—37-mm gun breechblock, rear and sectioned views.

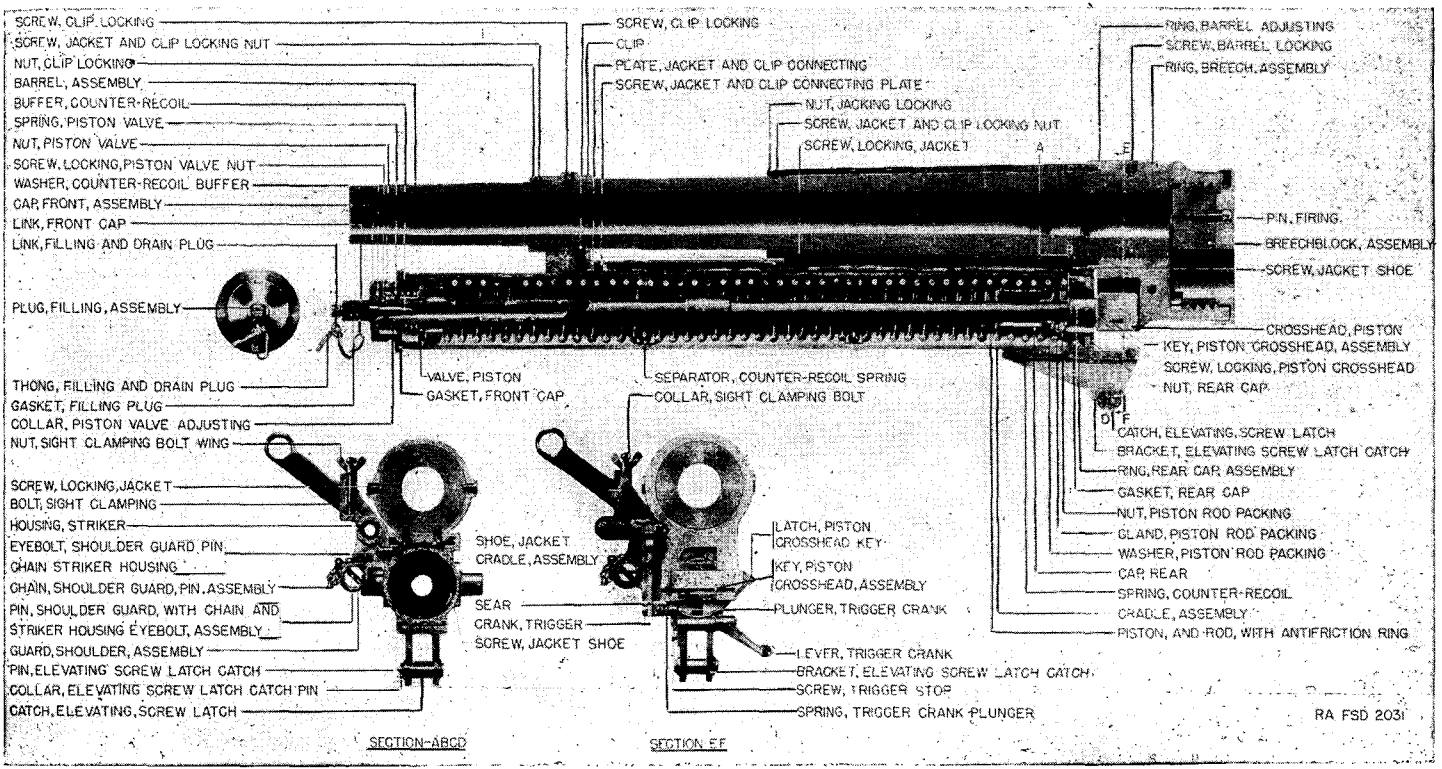


FIGURE 110.—37-mm gun and recoil mechanism, sectioned views.

b. Safety bolt.—The safety bolt prevents firing of the gun if the breechblock is not fully closed.

c. Firing mechanism.—The firing mechanism consists of the firing pin, firing pin spring, rocker, rocker pin, rocker pin latch, and rocker plunger which are housed in the breechblock. When the trigger crank lever is pressed down the firing pin strikes the percussion cap, thus firing the gun.

114. Description of recoil mechanism.—*a.* The recoil mechanism is located in the cradle underneath the gun, and upon it the gun slides during recoil and counterrecoil. It consists of the recoil mechanism, the counterrecoil mechanism, and the counterrecoil buffer (fig. 110).

b. The recoil mechanism is for the purpose of controlling the force created by firing and to check movement of the gun in a gradual manner. The counterrecoil mechanism is for the purpose of returning the gun into battery in order that it may be fired again. The counterrecoil buffer is for the purpose of slowing down and stopping the counterrecoil action without injury to the system.

115. Breech mechanism.—*a. Operation.*—(1) *To cock.*—Place the palm of hand against cocking handle of striker and push it forward until it latches. After the first shot the mechanism is automatically cocked. If round is not to be fired, remove it from gun. Do not uncock while gun is loaded as the mechanism must be cocked before it can be opened.

(2) *To open breech.*—(*a*) Rotate breechblock lever to left as far as it will go (fig. 109).

(*b*) The gun has no breechblock latch to hold breechblock in open or closed position. However, if the firing mechanism has been tripped, it will be necessary first to cock mechanism before breech may be opened.

(3) *To load.*—Insert round of ammunition, pushing cartridge case in as far as allowed by extractor.

(4) *To close breech.*—(*a*) Grasp breechblock lever and rotate it to right as far as it will go.

(*b*) During first part of movement a ramp on front of breechblock pushes cartridge case in flush with face of breechblock. It is pushed home by forward movement of breechblock in the breech ring threads.

b. Disassembly and assembly.—(1) *To dismount breechblock.*—(*a*) Cock piece with left hand by means of cocking handle on striker rod. Remove breechblock lever with right hand by grasping handle with the fingers and pressing breechblock lever release pin cap with the thumb.

(*b*) Take out extractor pin by pressing extractor pin latch toward breech with left forefinger and pulling it out to right with the right hand. Extractor will drop down until its heel clears extractor cam.

(*c*) Unscrew breechblock, grasping it firmly in right hand and supporting it with left hand, and remove it by unscrewing to left.

(2) *To replace breechblock.*—(*a*) See that breech recess, extractor, and threads of breechblock are thoroughly cleaned and lightly oiled. Set extractor in its seat but do not put in extractor pin.

(*b*) Cock.

(*c*) Screw breechblock home.

(*d*) Put breechblock lever in place.

(*e*) Raise extractor by pushing upward on its heel from under block and put extractor pin in from the right until extractor pin latch springs out and secures the pin.

(*f*) Uncock by pressing down trigger lever with right thumb while using pressure against cocking handle with left hand to prevent too fast movement of striker.

(3) *To dismount extractor.*—(*a*) Dismount breechblock as directed in (1) above.

(*b*) Withdraw extractor by inserting left forefinger in mortise in base of breech ring, raising extractor a little and grasping it with thumb and finger of right hand.

(*c*) To assemble extractor see (2)(*e*) above.

NOTE.—Do not attempt to unscrew or screw in breechblock without first removing extractor pin.

(4) *To dismount rocker, rocker plunger, and firing pin.*—(*a*) Mechanism should be cocked or breechblock dismounted.

(*b*) The rocker pin is retained in its seat by the free end of the spring entering the groove in outer end of rocker pin. This spring may become stuck with paint and should be freed by scraping paint around edge before attempting to remove rocker pin.

(*c*) Head of rocker pin projects at one side of the port. Place a small bronze drift against the projecting head and with light taps drive pin into the port. Rocker is then free and when removed exposes the firing pin, which will be pushed out by its spring and the rocker plunger, all of which may then be taken out.

(5) *To assemble rocker, rocker plunger, and firing pin.*—(*a*) Clean and lubricate all parts; put in rocker plunger, firing pin spring, and firing pin.

(*b*) Hold rocker down in its seat with thumb until rocker pin can be started through. Push pin home and see that rocker pin latch springs into the groove.

(6) *To remove piston cross head key.*—Disengage striker. Press up on piston cross head key latch and push key out to left.

(7) *To assemble piston cross head key.*—Clean, examine, and lubricate parts and push key in place with trigger crank lying in front of long arm of sear. See that safety bolt properly engages depending arm of sear before piston cross head key is pushed fully home. Failure to have safety bolt in proper position will prevent cross head key from being fully pushed in, and an attempt to force it will cause damage to the sear.

(8) *To disassemble striker mechanism.*—Having removed piston cross head key, draw gun back about 8 inches and push striker to its extreme forward position to loosen striker rod nut setscrew and unscrew striker rod nut. Allow spring to expand slowly and push striker rod out. Clean all parts. Free height of the striker spring should be 6.81 inches. If it is as much as 0.5 inch less than this, replace it with a new spring.

(9) *To assemble striker mechanism.*—Thoroughly slush striker spring and striker rod with light oil. Place striker spring over rod and insert them in striker housing. Push striker to extreme forward position and screw nut until front edge of nut is about flush with front end of striker rod, taking care that striker rod nut setscrew comes opposite its keyway in the striker housing. The stroke of the striker rod may be lengthened by unscrewing striker rod nut a few turns. The setscrew must not be omitted and must be well set in so that it does not strike the bottom of the keyway.

116. Gun and cradle disassembly and assembly.—*a. Disassembly.*—(1) Remove flash hider, if present, by taking out flash hider collar clamp bolt.

(2) Release striker and take out piston cross head key by pressing up on its latch and pushing it out to left.

(3) Draw gun back carefully off cradle by grasping muzzle with the left hand and breech with the right.

b. Assembly.—(1) See that gun slides and piston cross head are thoroughly cleaned and lubricated.

(2) Insert gun from rear, carefully maintaining alinement to avoid jamming gun slides.

(3) Replace piston cross head key.

117. Inspection.—Careful and frequent inspection should be made of the matériel to discover any parts which need attention or adjustment.

Parts to be inspected	*Points to observe*
a. Gun and recoil mechanism as a unit.	*a.* General appearance. Condition of paint. Try ejection with empty shell case.
b. Breechblock.	*b.* Rotate breechblock from right to left and back several times, noting whether there is any stiffness or binding. Depress breechblock lever release pin cap and pull out breechblock lever. Remove extractor pin. Then rotate breechblock in a counterclockwise direction until threads on breechblock are disengaged from threads in barrel and examine threads on breechblock for burs and rough surfaces. Note firing pin hole in face of breechblock, depress rocker plunger, and note how far firing pin protrudes. With rocker plunger fully depressed, firing pin should protrude approximately $\frac{1}{8}$ inch. Remove rocker pin, turn breechblock over and allow rocker plunger, firing pin, and firing pin spring to drop out. Note these parts for rust and burred surfaces. Tension of firing pin spring, free length, is $2\frac{5}{32}$ inch. Try tension of breechblock lever latch spring.
c. Firing mechanism.	*c.* Try tension of striker spring and sear plunger spring. Try action of trigger crank and trigger crank lever. Trigger crank plunger should have tension enough to hold trigger crank in place. Note sear and sear notch for burs or worn surfaces.
d. Barrel.	*d.* Note threads in breech for burs and rough surfaces. Chamber and barrel should be free from pits and rust. Remove piston cross head key and slide barrel back to insure that jacket shoe and recoil ways are free from burs.
e. Recoil mechanism.	*e.* (1) Remove barrel assembly from recoil mechanism and note front and rear caps for oil leaks and leaks at piston rod packing washer. Check quantity of oil in recoil mechanism. (2) Make a retraction test. A simple retraction test may be made by manually re-

tracting the gun, blocking it with a piece of wood about 10 inches long, and then pulling out the block with a cord or wire. The gun should return to battery quickly but without shock.

118. Malfunctions.—*a.* The gun may under certain conditions either fail to return completely to battery or may return too suddenly with a shock which will tend to destroy the aim. The firing mechanism may jam, or there may be a defective discharge, or failure to eject empty cartridge case properly.

b. Incomplete return to battery is evident when the firing mechanism does not cock, or the cocking is not sufficient to produce discharge of the next shot. This may be caused by weakened counterrecoil springs, scored or scratched jacket shoe guides, a bent recoil cylinder, or an excess of oil in the recoil mechanism, which is due to expansion of the oil caused by excessive friction accompanying continued firing. In the latter case a little oil may be let out of the recoil mechanism by unscrewing the drain plug located on the rear right side of the cradle. If it is thought that the condition of the guides is causing the difficulty, the gun should be dismounted and the guides examined for traces of excessive friction, scratches, fouling, etc. This may be remedied by careful use of a fine file and thorough cleaning and oiling. Test the operation of the gun in the slides before replacing the piston cross head key.

c. Sudden return into battery position with a jarring impact is due to incomplete buffing at the end of counterrecoil or to insufficient oil in the recoil mechanism. Ordinarily addition of a little oil will remedy both of these conditions. To do this, remove filling plug at front of cradle and inject sufficient oil by means of the oil gun.

d. Where trigger crank lever cannot be depressed sufficiently to operate firing mechanism, the malfunction can usually be attributed to incomplete closure of the breech which causes the safety mechanism to lock the sear. The cartridge case should be examined for damaged rim or other defects tending to prevent its insertion in the chamber. Another shell may be tried. If the loading is not the cause of the difficulty, examine chamber for dirt or fouling and trigger mechanism for broken or damaged parts or foreign matter which has become caught in the mechanism. Broken or damaged parts should be replaced.

e. Failure to fire is due either to a defective primer, a weakened striker spring, a worn or broken firing pin, or dirt in the firing pin recess. If two percussions are frequently necessary to produce dis-

charge, the striker spring has either become weakened and should be replaced, or it is clogged with dirt and hardened grease so that it cannot function properly. If no defect can be found in the firing mechanism and the shell does not fire after three percussions wait for 2 minutes, then replace it with another, as the primer is defective.

f. Defective extraction may occur when a cartridge case tends to stick in the chamber, when edge of chamber is burred or fouled with powder, or when the extractor is damaged or broken. A poor cartridge case may cause sticking in the chamber due to expansion, in which case the hand extractor should be used to complete extraction. Careful use of a fine file will correct sticking due to burring of chamber. If extractor is broken or damaged it should be replaced.

g. The various causes of irregularity in operation are—

(1) *Failure to fire.*—(*a*) Breech not closed.
(*b*) Broken sear.
(*c*) Gun not cocked.
(*d*) Defective ammunition.
(*e*) Defective firing pin.
(*f*) Weak striker spring.

(2) *Failure to extract.*—(*a*) Breech opened slowly.
(*b*) Dirty chamber.
(*c*) Extractor pin out.
(*d*) Burred chamber.
(*e*) Swollen cartridge case.
(*f*) Defective extractor.

(3) *Failure to return to battery.*—(*a*) Too much oil in recoil mechanism.
(*b*) Dirty slides.
(*c*) Bent shoes or slides.
(*d*) Burred shoes or slides.
(*e*) Defective cradle.

(4) *Breech will not open.*—(*a*) Gun not cocked due to—
1. Worn or broken sear.
2. Worn or broken shoulder on striker rod.
3. Defective sear plunger and springs.
4. Gunner failed to release trigger crank lever.
(*b*) Firing pin stuck in primer caused by—
1. Burred rocker.
2. Defective primer.

119. Care and preservation.—*a. Gun.*—The matériel should be kept in perfect condition and thoroughly cleaned and oiled. Only such cleaning and preserving materials as are issued for this purpose

will be used. It is especially important that all parts of the gun be kept free from rust. The following instructions for cleaning these parts will be strictly observed:

(1) The bore and chamber of the gun require particular attention and will be thoroughly cleaned within 1 hour after firing. To prepare cleaning solution dissolve one part, by volume, of soda ash in four parts of water. Hot water, not boiling, is better than cold. Place the barrel on a rack or table, remove breechblock and extractor, and clean bore thoroughly with the soda ash solution. This can best be done by mixing the solution in a bucket. Place a bucket under the breech, dip a cleaning brush in solution, and work it briskly back and forth in the bore until clean. Dry the bore thoroughly, using burlap or cloths, and oil with oil, engine, SAE 10, for temperatures below 32° F., or oil, engine, SAE 30, for temperatures above 32° F.

(2) Clean breechblock and firing mechanism thoroughly. Lightly oil all parts and recesses and breechblock threads with oil, engine, SAE 10 or 30.

(3) Keep trigger mechanism free from dust and foreign matter. After use, carefully wipe all parts dry and apply a drop of light lubricating oil on striker bearings, trigger bearings, and safety bolt.

(4) Clean gun slides and oil freely with oil, engine, SAE 10 or 30.

b. Recoil mechanism.—To fill an empty recoil mechanism 2¾ pints of oil, or 21 oil gun fills, are required. Heavy recoil oil only is issued for use in the recoil mechanism.

(1) *Procedure.*—Rear end of cradle should be higher than the front.

(*a*) Fill oil gun.

1. Unscrew nozzle of oil gun.

2. Pull plunger back.

3. Fill oil gun with heavy recoil oil.

4. Replace nozzle.

5. Push plunger up gently to force out the air.

(*b*) Remove filling plug.

(*c*) Screw oil gun into filling hole.

(*d*) Remove drain plug.

(*e*) Push plunger of oil gun in slowly, and at the same time watch for the escape of oil from the drain hole. When oil runs out free of air bubbles recoil mechanism is full.

(*f*) Remove oil gun. Before replacing the filling and drain plugs let about two teaspoonfuls of oil escape, then screw the two plugs in tightly. This is necessary as the expansion of oil during pro-

longed fire may interfere with the complete return of the gun to battery.

(2) *Adjustment.*—No adjustment of recoil mechanism by the using arm is permitted. Report defects to ordnance personnel.

120. Precautions.—The precautions which must be observed before, during, and after firing are as follows:

a. Before firing.—See that—

(1) Bore is clean and dry.

(2) Recoil mechanism is correctly filled.

(3) Sight is clean, adjusted, and lock-nuts tight.

(4) All parts are functioning properly.

(5) Spare parts set is complete.

(6) All moving parts are oiled.

(7) Retraction test is made (see par. 117*e*(2)).

b. During firing.—(1) In case of a misfire recock, relay, and make three attempts to fire. If the failure continues, wait 2 minutes before opening breech.

(2) Release trigger crank lever promptly.

c. After firing.—(1) Clean piece thoroughly within 1 hour after firing.

(2) Examine gun and cradle for worn, loose, or broken parts.

121. Practices to be avoided.—Certain practices which must be avoided in order to maintain efficient operation are—

a. Ordnance personnel, only, may repair or disassemble the recoil mechanism. The using arm may fill or drain it as necessity requires.

b. Avoid working the trigger mechanism when there is no cartridge in the chamber, and do not attempt to force the trigger crank lever when the breech is not completely closed, as the sear is locked by the safety bolt on the underside of the breech ring.

c. Breechblock should not be moved when the striker is not cocked.

d. The walls of the recoil cylinder and striker housing attached to the cradle are relatively thin. Therefore, dropping the cradle may dent them and cause internal interferences. Clamping the cradle in a vise without proper holding blocks will also tend to distort and ruin it.

122. Lubricating instructions.—*a.* Proper lubrication of bearing surfaces is necessary if the mechanism is to function smoothly and give long service. The 37-mm gun matériel has very few oil holes or special lubricating fittings, yet it requires frequent oiling of certain bearings.

b. The following chart gives locations where lubrication will be necesary, kind of lubricant, amount required, and frequency and

method of application required for 37-mm gun matériel in active service.

Lubrication chart, 37-mm gun matériel M1916

Part	Method	Lubricant	Remarks
Bore	Slush	For temperatures below 32° F. oil, engine, SAE 10. For temperatures above 32° F. oil, engine, SAE 30.	Daily and after firing. First clean bore. See paragraph 119*a*(1).
Breechblock	Spread oil on threads.	do	Daily. Unscrew breechblock.
Firing pin	Drops at contact surfaces.	do	Daily. While breechblock is dismounted.
Extractor and extractor pin.	do	do	Do.
Safety bolt	Drops at ends of bracket.	do	Do.
Striker rod	do	do	Do.
Sear	Drops at bearing surface.	do	Do.
Piston cross head key.	Drops at contact surfaces.	do	At assembly.
Striker spring	Slush	do	Do.
Gun slides	Cover bearing surfaces.	do	Dismount gun. See paragraph 116*a*.
Trigger crank	One drop at each end of bearing.	do	Daily.

123. Gun mounts.—*a. Description and operation.*—(1) *37-mm subcaliber mount M2* (fig. 112).—The assembled mount is composed of a front and rear support. These supports form a rigid mounting for the 37-mm gun and recoil mechanism when mounted on the 75-mm gun M1897. The front support consists of a bracket with U-bolts, nuts, and adjusting screws. The bracket fits around the 37-mm gun recoil mechanism and the U-bolts around the 75-mm gun barrel. The rear support is composed of a left and right bracket with the necessary studs, nuts, and adjusting screws. This support fits around the 75-mm gun barrel just in front of and against the jacket and onto the trunnions of the 37-mm gun recoil mechanism. The rear support is sufficient to withstand all forces of firing. The front sup-

port is necessary to permit alinement of the 37-mm gun with the 75-mm gun.

(2) *37-mm subcaliber mount M7* (fig. 113).—The mount, consisting mainly of a three-legged bracket, forms a rigid support for the 37-mm gun and recoil mechanism on the 75-mm gun carriage M2A1, M2A2, or M2A3. The three-legged bracket straddles the rear portion of the 75-mm gun and is attached to the support directly over the cradle trunnion by two cap screws, the front legs being bolted to the cradle of the 75-mm gun recoil mechanism by means of cap screws, lock washers, and nuts. A small triangular bracket when

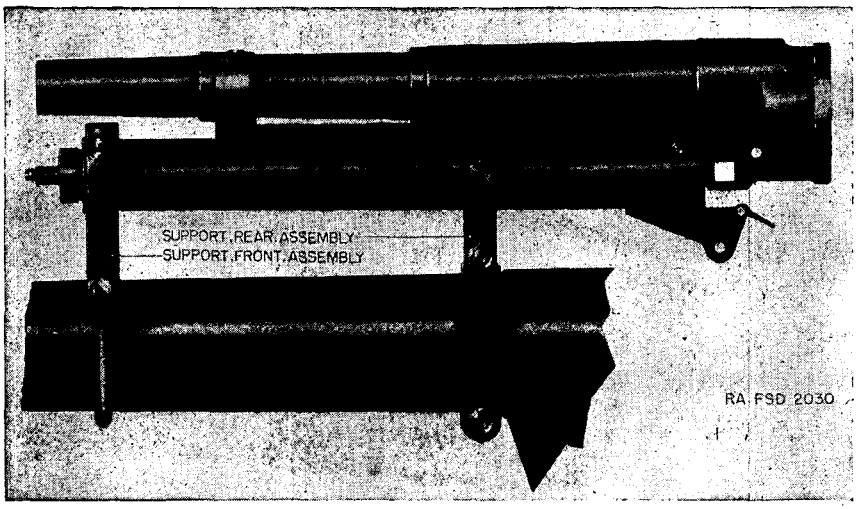


FIGURE 111.—37-mm subcaliber mount M2.

bolted to the support bracket forms a trunnion bearing which is provided with fillister head cap screws and jam nuts to retain the gun cradle in position, and also provides a means of adjustment for deflection. The two fillister head cap screws and the adjusting screw with their jam nuts at the front of the bracket provide a means of adjusting the 37-mm gun when bore sighting on the testing target.

(3) *37-mm subcaliber mount M8* (fig. 114).—The mount, consisting mainly of a four-legged bracket, forms a rigid support for the 37-mm gun and recoil mechanism on the gun carriages M1897MIA2 and M1897A4. The four-legged bracket straddles the rear portion of the 75-mm gun and is attached by means of pins to the supports which are fastened by screws to the cradle of the 75-mm gun recoil mechanism. A small triangular bracket when bolted to the support bracket forms a trunnion bearing which is provided with fillister

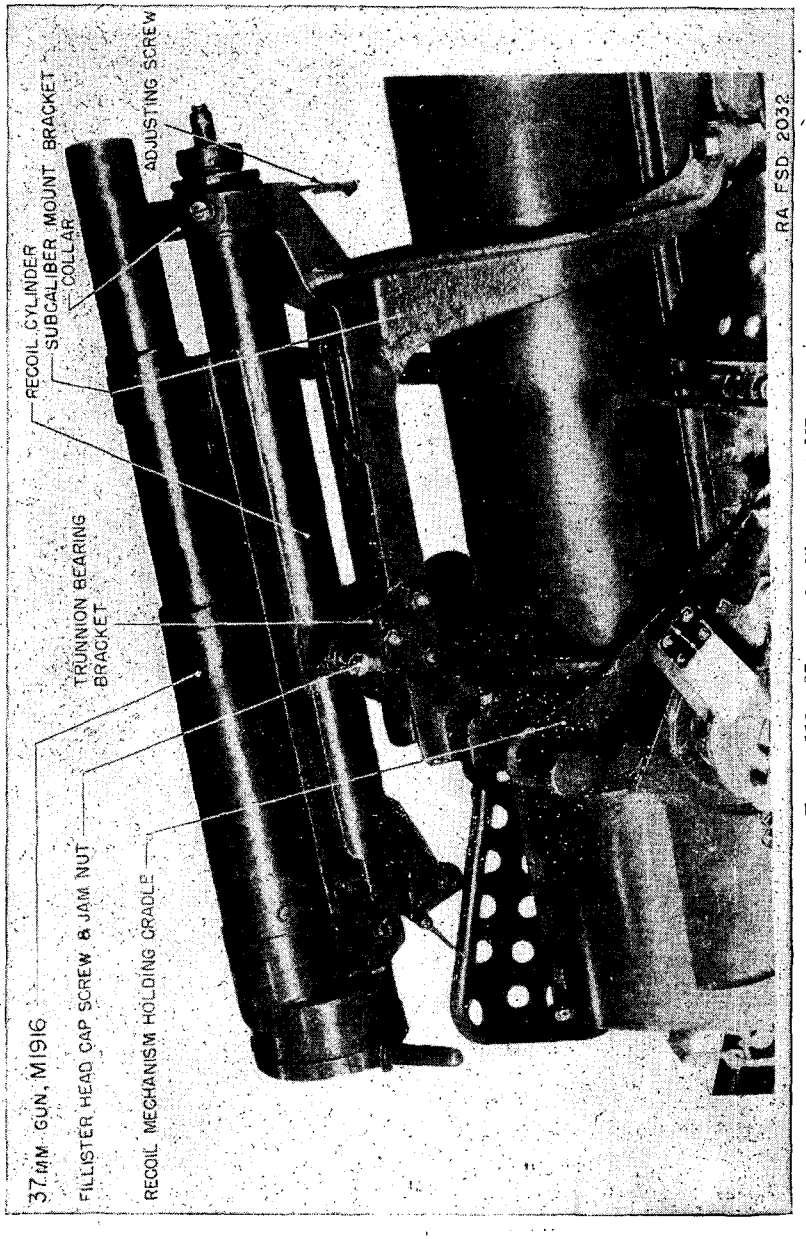


FIGURE 112.—*37-mm subcaliber mount M7.*

head cap screws and jam nuts to retain the gun cradle in position and to provide a means for adjustment for deflection. The two fillister head cap screws and the adjusting screw with their jam nuts at the front of the bracket provide a means of adjusting the 37-mm gun when bore sighting.

b. Assembly and disassembly.—(1) *37-mm subcaliber mount M2* (fig. 111).—(*a*) In assembling and mounting the supports, gun, and recoil mechanism on the 75-mm gun, the first operation is to place the front bracket on the 37-mm gun recoil mechanism. This is accomplished by slipping it over the front end of the recoil mechanism, counterbored part to front, and tightening adjusting screws slightly.

(*b*) The gun and recoil mechanism are placed upon the muzzle end of the 75-mm gun with the trunnions of the 37-mm gun approximately 1 inch in front of the 75-mm gun jacket. The U-bolt is placed around the barrel of the 75-mm gun and up through the holes provided in the front bracket, and the nuts are screwed on and slightly tightened.

(*c*) The rear brackets, left and right, form the rear support when assembled. This is assembled against the front end of the jacket of the 75-mm gun and over the trunnions of the 37-mm gun recoil mechanism. The adjusting cap screws are tightened slightly against the trunnions and adjustments made. The long studs are then inserted in the brackets and nuts placed thereon. These are tightened sufficiently to hold gun and recoil mechanism in position.

(*d*) After the rear support is properly alined and adjusted, the nuts and adjusting screw are tightened. The front support is in its proper position when its adjusting screws are tangent to the flange of the front cap (fig. 111).

(2) *37-mm subcaliber mounts, M7 and M8.*—(*a*) Place subcaliber mounts in positions as shown in figures 112 and 113, respectively. The mounts are fastened by means of cap screws, or pins and supports. Release tension on jam nuts of adjusting screws at front of bracket. Remove small triangular bracket by disassembling nuts and lock washers from screws.

(*b*) Lift 37-mm gun and recoil mechanism and insert front end of recoil cylinder through band on front end of support bracket. Place trunnion of recoil mechanism in the trunnion bearing of the support bracket. Assemble the small triangular bracket over recoil mechanism trunnion, and bolt it in place. Tighten fillister head cap screws in trunnion bearing and those on the band of the front end of the bracket just sufficiently to retain the 37-mm gun in position.

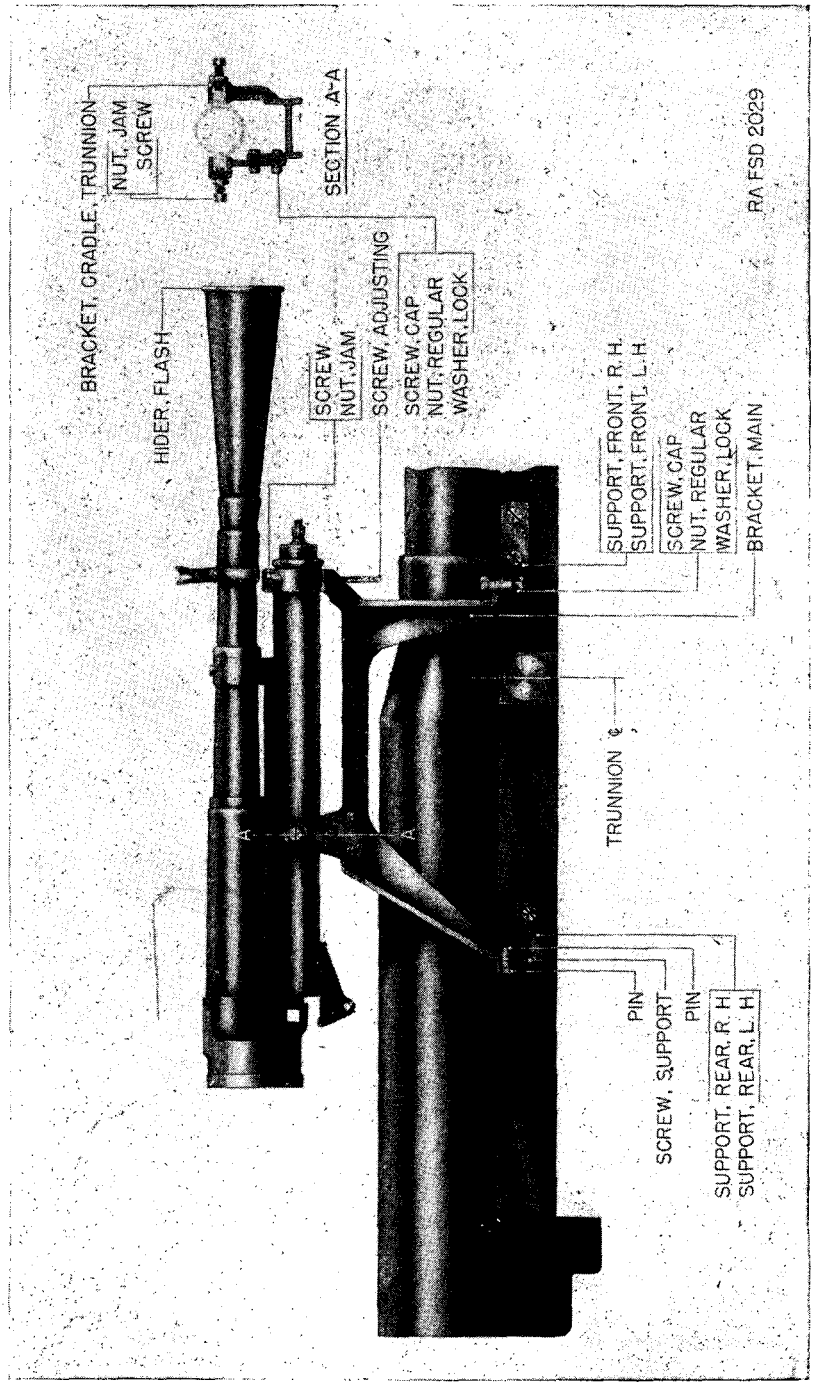


FIGURE 113.—37-mm subcaliber mount M8.

(3) *Disassembling.*—Disassembling is accomplished by loosening the adjusting screws and removing the supports. This requires no further explanation, as the procedure is elementary.

c. Care and preservation.—Repairs to the 37-mm subcaliber mounts will be minor and will involve only the removal of burs when necessary and the replacement of parts. When a subcaliber mount is dismounted all screws, nuts, and lock washers should be assembled to the mount to avoid loss.

124. Bore sighting.—After verification of the 75-mm gun sights has been accomplished as described in section II, chapter 3, it only remains to aline the bore of the 37-mm gun with that of the 75-mm gun. Procedure is as follows:

a. Make a testing target by wrapping two pieces of black tape of equal width around the aiming post. For the M2 mount, the lower edges should be exactly 10 inches apart; for the M7 mount, the lower edges should be exactly 14.375 inches apart; and for the M8 mount, the lower edges should be exactly 12.265 inches apart. By use of the aiming post as a testing target it will not be necessary to level the 75-mm gun, as the aiming post can be canted to conform to the angle of the gun so that the vertical line of bore of 75-mm gun will coincide with the side of the aiming post. The testing target should be placed about 50 feet from the gun.

b. Use bore sights to line up bore of 75-mm gun with the lower edge of the lower tape on aiming post.

c. Use bore sights for 37-mm gun and sight it on the lower edge of upper tape on aiming post.

d. All adjustments of the 37-mm gun upon testing target are made by adjusting screws in brackets that encircle recoil cylinder, and those in trunnion bearings.

e. When proper adjustment has been made set jam nuts up tight.

125. Miscellaneous operations.—*a. Counterbalancing 75-mm gun when used with M2 mount.*—With the 37-mm gun, recoil mechanism, and subcaliber mount in place, the increased force required to operate the 75-mm gun angle of site and elevating mechanisms without counterbalance is negligible. Counterbalance is not necessary for smooth operation, but desirable on account of field artillery procedure which calls for elevation of the breech as the last movement before firing. A weight of 66 pounds is necessary to counterbalance the weight of the 37-mm gun with the 75-mm gun in battery. This can be obtained in part by the use of the drill cartridge, and for the additional weight required small sandbags may be laid on or attached to the breech. No special equipment for this purpose will be pro-

vided. Empty cartridge cases filled with the required amount of lead, if available, make excellent counterweights. Withdrawing oil from the recuperator of the carriage in order to push the gun to the rear to overcome the weight of the subcaliber mount is prohibited. An excess reserve of recoil oil must be established in the primary weapon before firing the subcaliber gun.

NOTE.—Counterbalancing is not necessary with the M7 and M8 mounts.

b. Functioning.—The normal position for operating the subcaliber equipment is from the right side. Caution is required on the first round as the gunner is compelled to reach across the gun to cock the firing mechanism. Subsequent firing automatically cocks it.

c. Witness line.—After the 37-mm gun is alined, marks should be inscribed on the 75-mm gun with a chisel or other sharp-edged tool to aid further mounting of the subcaliber equipment. Witness lines are used only with the M2 mount, as the M7 and M8 mounts are located by means of their fixed brackets.

d. Care and maintenance.—When firing subcaliber, the primary tube should be covered to prevent damaging the paint. When firing with the M2 mount, an excess reserve should be placed in the recoil system of the 75-mm carriage, and a counterbalance should be used. When traveling, the 37-mm gun and recoil system should be removed. After firing both bores should be cleaned.

126. Spare parts and accessories.—*a. Spare parts.*—The spare parts issued with the subcaliber equipment are those which are liable to fail and which may be replaced readily by the using arm. These parts are specified in pertinent Standard Nomenclature Lists.

b. Accessories.—The accessories provided for the subcaliber weapon are those required for cleaning and preserving as well as for a complete record of the equipment. They include a gun book, cartridge extractor, bore brush, oil gun, cleaning staff, tool roll, etc.

c. Sighting and fire-control equipment.—For information as to the type and use or application of breech and muzzle bore sights which are provided with the 37-mm gun, see section II, chapter 3. Firing tables are also issued which contain firing data required for this type of firing with the 37-mm ammunition.

127. Ammunition.—Subcaliber ammunition is listed in paragraph 67.

CHAPTER 8

MATÉRIEL AFFECTED BY GAS

Paragraph
Protective measures 128
Cleaning 129
Decontamination 130

128. Protective measures.—*a.* When matériel is in constant danger of gas attack, unpainted metal parts will be lightly coated with oil. Instruments are included among the items to be thus protected from chemical clouds or chemical shell, but ammunition is excluded. Care will be taken that the oil does not touch the optical parts of instruments or leather or canvas fittings. Matériel not in use will be protected with covers as far as possible. Ammunition will be kept in sealed containers.

b. Ordinary fabrics offer practically no protection against mustard gas or lewisite. Rubber and oilcloth, for example, will be penetrated within a short time. The longer the period during which they are exposed, the greater the danger of wearing these articles. Rubber boots worn in an area contaminated with mustard gas may offer a grave danger to men who wear them several days after the bombardment. Impermeable clothing will resist penetration more than an hour, but should not be worn longer than this.

129. Cleaning.—*a.* All unpainted metal parts of matériel that have been exposed to any gas except mustard and lewisite must be cleaned as soon as possible with solvent, dry-cleaning, or alcohol, denatured, and wiped dry. All parts should then be coated with oil, engine, or oil, sperm. It is only necessary to decontaminate the exterior surfaces, the bore, the breechblock assembly, and all porous attachments such as straps, covers, etc., of artillery field pieces exposed to gas. It may therefore be assumed that all decontamination of artillery field pieces is to be carried out by the gun crews.

b. Ammunition which has been exposed to gas must be thoroughly cleaned before it can be fixed. To clean ammunition use agent, decontaminating, noncorrosive, or if this is not available, strong soap and cool water. After cleaning, wipe all ammunition dry with clean rags. *Do not use dry powdered agent, decontaminating (chloride of lime) (used for decontaminating certain types of matériel on or near ammunition supplies)*, as flaming occurs through the use of chloride of lime on liquid mustard.

130. Decontamination.—For the removal of liquid chemicals (mustard, lewisite, etc.) from matériel, the following steps should be taken:

a. Protective measures.—(1) For all of these operations a complete suit of impermeable clothing and a service gas mask will be worn. Immediately after removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. If any skin areas have come in contact with mustard, if even a very small drop of mustard gets into the eye, or if the vapor of mustard has been inhaled, it is imperative that complete first-aid measures be given within 20 to 30 minutes after exposure. First-aid instructions are given in TM 9–850 and FM 21–40.

(2) Garments exposed to mustard will be decontaminated. If the impermeable clothing has been exposed to vapor only, it may be decontaminated by hanging in the open air, preferably in sunlight, for several days. It may also be cleaned by steaming for 2 hours. If the impermeable clothing has been contaminated with liquid mustard, steaming for 6 to 8 hours will be required. Various kinds of steaming devices can be improvised from materials available in the field.

b. Procedure.—(1) Commence by freeing matériel of dirt through the use of sticks, rags, etc., which must be burned or buried immediately after this operation.

(2) If the surface of the matériel is coated with grease or heavy oil, this grease or oil should be removed before decontamination is begun. Solvent, dry-cleaning, or other available solvents for oil should be used with rags attached to ends of sticks. Following this, decontaminate the matériel with bleaching solution made by mixing one part agent, decontaminating (chloride of lime), with one part water. This solution should be swabbed over all surfaces. Wash off with water, dry, and oil all surfaces.

(3) All unpainted metal parts and instruments exposed to mustard or lewisite must be decontaminated with agent, decontaminating, noncorrosive, mixed one part solid to fifteen parts solvent (acetylene tetrachloride). If this is not available, use warm water and soap. Bleaching solution must not be used, because of its corrosive action. Instrument lenses may be cleaned only with paper, lens, tissue, using a small amount of alcohol, ethyl. Coat all metal surfaces lightly with oil, engine, or oil, sperm.

(4) In the event agent, decontaminating (chloride of lime) is not available, matériel may be temporarily cleaned with large volumes of hot water. However, mustard lying in joints or in leather or canvas webbing is not removed by this procedure and will remain a constant

source of danger until the matériel can be properly decontaminated. All mustard washed from matériel in this manner lies unchanged on the ground, necessitating that the contaminated area be plainly marked with warning signs before abandonment.

(5) The cleaning or decontaminating of matériel contaminated with lewisite will wash arsenic compounds into the soil, poisoning many water supplies in the locality for both men and animals.

(6) Leather or canvas webbing that has been contaminated should be scrubbed thoroughly with bleaching solution. In the event this treatment is insufficient, it may be necessary to burn or bury such matériel.

(7) Detailed information on decontamination is contained in FM 21–40 and TM 9–850.

APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.—*a. Ammunition.*

Ammunition, blank, for pack, light, and medium field artillery ..... SNL R–5.
Ammunition, fixed, all types, for pack, light, and medium field artillery ..... SNL R–1.
Ammunition instruction material for pack, light, and medium field artillery ..... SNL R–6.
Service fuzes and primers for pack, light, and medium field artillery ..... SNL R–3.
b. Cleaning and preserving materials ..... SNL K–1.
c. Gun matériel.
Caisson, 75-mm gun, M1918; limber, caisson, 75-mm gun, M1918; and limber, carriage, 75-mm gun, M1918 ..... SNL C–5.
Cart, artillery, M1918 and M1918A1 ..... SNL C–11.
Gun and carriage, 37-mm, M1916 and carriages, 37-mm gun, M1916A1 and M1916A2 ..... SNL A–7.
Gun and carriage, 75-mm, M1897M1 and M1897M1A2 ..... SNL C–4.
Gun and carriage, 75-mm, M2A1, M2A2, and M2A3 ..... SNL C–12.
Gun and carriage, 75-mm, M1897A4 ..... SNL C–25.
Major items, small arms, automatic gun, trench mortar, and field artillery sighting equipment and fire-control instruments ..... SNL F–1.
Reel, battery, M1917 ..... SNL C–10.

d. Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" (OPSI).

2. Explanatory publications.

a. Ammunition, general ..... TM 9–1900.
b. Cleaning and preserving materials ..... TM 9–850.
c. Gun and carriage.
Defense against chemical attack ..... FM 21–40.
Pressure gage outfits for cannon ..... TM 9–1870.
(now published as supplement to SNL N–9)

Service of the piece, 75-mm gun M1897 and M1897A4, horse-drawn and truck-drawn.	FM 6–50.
Service of the piece, 75-mm gun matériel M2, 37-mm gun M1916.	FM 6–55. FM 23–75.

d. Lubrication instructions for the 75-mm guns and carriages ..... Lubrication Guides.

3. Firing tables and trajectory diagrams.—*a. Gun, 75-mm, M1897, M1897A1, M1897A2, M1897A3, and M1897A4.*

Shell, fixed, chemical, Mk. II, with fuze, PD, Mk. III, M46, or M47, 75-mm gun, M1897. Shell, fixed, HE, Mk. I, with fuze, PD, Mk. III, M46, or M47, 75-mm gun, M1897. Shell, fixed, practice, sand-loaded, Mk. I, with fuze, inert, PD, Mk. IV, 75-mm gun, M1897. Shrapnel, fixed, Mk. I, 75-mm gun, M1897.	FT 75–B–4.
Shell, fixed, chemical, Mk. II, with fuze, PD, M35, 75-mm gun, M1897. Shell, fixed, HE, Mk. I, with fuze, PD, M35, 75-mm gun, M1897.	FT 75–B–4 (supplement).
Shell, HE, Mk. I, with fuze, long, Mk. III, normal charge, 75-mm gun, M1897.	TD 75–B–2, 2d.
Shell, HE, Mk. I, with fuze, PD, M46, M47, reduced charge, 75-mm gun, M1897.	TD 75–B–4, 2b.
Shell, HE, Mk. I, with fuze, PD, M46, M47, normal charge, 75-mm gun, M1897.	TD 75–B–4, 2c.
Shell, fixed, HE, M48, with fuze, PD, M48, M54, 75-mm gun, M1897.	FT 75–Z–2. TD 75–Z–2.

b. Gun, subcaliber, 37-mm, M1916, on subcaliber mount.

Shell, fixed, practice, Mk. II, with fuze, practice, M38, 37-mm gun, M1916.	FT 37–0–1 (abridged).

c. Current firing tables are as tabulated here. An up-to-date list of firing tables is maintained in SNL F–69.

INDEX

	Paragraph	Page
Abrasives and cleaners	38	35
Accessories	109	219
Subcaliber equipment	124	242
Adapter, high speed, care and preservation	35	33
Aiming circles	54	105
Aiming post M1	48	90
Ammunition	61–72	140
Care and preservation	66	144
Classification	62	140
Fuzes	68	147
Combination, 21-second, M1907M	70	150
Point detonating	69	147
Identification	63	140
Marking	64	141
Weight zone	65	143
Packing	71	151
Painting	64	141
Rounds, authorized	67	144
Subcaliber	72	151
Assembly:		
Adapter, high speed, carriage M1897A4	20	16
Axle, carriage M1897 and M1897MIA2	18	16
Gun	11	13
Subcaliber	114	229
Wheels, carriage:		
M1897 and M1897MIA2	17	16
M2A2	25	19
Bore sighting with subcaliber equipment	124	242
Bracket, fuze setter	57	132
Brake, gun carriage, M1897 and M1897MIA2, disconnecting and connecting to axle	16	16
Brake mechanism, gun carriage, M2A2, care and preservation	36	34
Breech mechanism:		
Disassembly	12	13
Subcaliber, description	113	226
Breechblock:		
Description	7	5
Subcaliber	113	226
Disassembly	12	13
Operation	8	5
Care and preservation:		
75-mm gun matériel M1897	31–42	27
Special field artillery vehicles	100–107	209

INDEX

	Paragraph	Page
Carriage, 75-mm gun:		
Care and preservation	32	29
Cleaners and abrasives	38	35
Data	5	3
Description	9	6
Inspection and adjustment	27	20
Lubricants	41	43
Lubrication instructions	37	35
Materials and tools	42	44
M1897 and M1897MIA2:		
Axle, removal and assembly	18	16
Brake, disconnecting and connecting to axle	16	16
Recoil mechanism, mounting and dismounting	15	15
Shield, removal	13	14
Wheels, removal and assembly	17	16
M1897A4:		
Adapter, high speed, disassembly and assembly	20	16
Disassembly	19	16
Recoil mechanism, mounting and dismounting	15	15
Shield, removal	13	14
M2A2:		
Brake mechanism, care and preservation	36	34
Equilibrator, mounting and dismounting	23	18
Recoil mechanism, mounting and dismounting	22	17
Wheel hub, disassembly from spindle	24	19
Wheels, assembly	25	19
Operation	10	10
Paint and related materials	40	40
Preservatives	39	40
Chains	82	166
Chart, lubrication:		
75-mm gun and carriage	37	35
Special field artillery vehicles	73	162
Chest, caisson limber	84	168
Chest, carriage limber	84	168
Circles, aiming	54	105
Clamp, pole	84	168
Cleaners and abrasives	38	35
Cleaning of matériel affected by gas	129	244
Compass, prismatic, M1918 (Sperry)	54	105
Data:		
Guns	4	3
Gun carriages	5	3
Special field artillery vehicles	73–77	162
Decontamination	130	245
Disassembly:		
Breech mechanism	12	13
Breechblock	12	13
Carriage M1897A4	19	16
Adapter, high speed	20	16

Disassembly—Continued.	Paragraph	Page
Cradle, subcaliber gun	116	231
Gun, 75-mm	11	13
M1897A4	19	16
Subcaliber	116	231
Doubletrees:		
Description	80	165
Dismounting	93	194
Mounting	93	194
Maintenance	100	209
Equilibrator, gun carriage, M2A2, mounting and dismounting	23	18
Equipment:		
Fire-control:		
Care and preservation	60	137
Circles, aiming	54	105
Compass, prismatic, M1918 (Sperry)	55	117
Firing table	58	133
Fuze setter, bracket, M1916	57	132
Range finder, 1-m base, M1916	56	126
Telescope, battery commander's, M1915	59	133
Sighting:		
Adjustment	28	23
Aiming post M1	48	90
Lamp (lantern M2)	43	78
Inspection	28	23
Mounts, telescope:		
M15	44	79
M15A1 and M22	45	86
Panoramic:		
M5 and M5A2	44	79
M5A4 and M12A1	45	86
Quadrants:		
Gunner's	49	91
Range	50	94
Sights:		
Bore	51	95
M1901 (French)	52	97
Testing targets	53	104
Subcaliber	110	219
Accessories	126	243
Ammunition	127	243
Bore sighting	124	242
Breech mechanism	115	229
Description	113	226
Breechblock, description	113	226
Care and preservation	119	234
Gun and cradle, disassembly and assembly	116	231
Inspection	117	231
Lubrication instructions	122	236
Malfunctions	118	233

	Paragraph	Page
Equipment—Continued.		
Subcaliber—Continued.		
Mounts, gun	123	237
Operations with	125	242
Precautions for	120	236
Recoil mechanism, description	114	229
Spare parts	126	243
Fastenings, wheel	78	163
Finder, range, 1-m base, M1916	56	126
Fire-control equipment	54–60	105
Firing mechanism, operation	8	5
Firing table	58	133
Fuze setter, bracket, M1916	57	132
Fuzes	68	147
Combination, 21-second, M1907M	70	150
Point detonating	69	147
Gun, 75-mm:		
Adjustment	28	23
Ammunition	61–72	140
Assembly and disassembly	11–25	13
Care and preservation	31	27
Cleaners and abrasives	38	35
Data	4	3
Description	6, 7	4, 5
Equipment:		
Fire-control	54–60	105
Sighting	43–53	78
Inspection	26	19
Lubricants	41	43
Lubrication instructions	37	35
M1897 and M1897MIA2, dismounting and mounting	14	15
M1897A4:		
Disassembly	19	16
Dismounting and mounting	14	15
M2A2, dismounting and mounting	21	17
Malfunctions	29	23
Materials and tools	42	44
Mounts, subcaliber	123	237
Operation	8	5
Paint and related materials	40	40
Preservatives	39	40
Inspections:		
Carriage	27	20
Equipment:		
Sighting	28	23
Subcaliber	117	231
Gun	26	19
Special field artillery vehicles	99	208

	Paragraph	Page
Instruments, care and preservation	60	137
Lamp, aiming post (lantern M2)	43	78
Latches, pintle:		
Description	81	166
Dismounting	93	194
Limbers:		
Animal-drawn	84	168
Tractor-drawn	84	168
Lubricants	41	43
Lubrication instructions	37	35
Special field artillery vehicles	99–107	208
Subcaliber equipment	122	236
Lunettes:		
Description	81	166
Dismounting and replacing	93	194
Maintenance	100	209
Malfunctions:		
Gun	29	23
Recoil mechanism	30	25
Subcaliber equipment	118	233
Markings, ammunition	64	141
Weight zone	65	143
Materials, gun	42	44
Affected by gas:		
Cleaning	129	244
Decontamination	130	245
Protection	128	244
Mounts:		
Gun, subcaliber	123	237
Telescope:		
M15	44	79
M15A1 and M22	45	86
Panoramic:		
M5 and M5A2	44	79
M5A4 and M12A1	45	86
Oil, recoil	34	32
Padlocks	82	166
Paint and related materials	40	40
Painting ammunition	64	141
Parts, spare:		
75-mm gun and carriage	108	219
Subcaliber equipment	126	243
Pins, pole	79	165
Pintles:		
Description	81	166
Dismounting and replacing	93	194
Maintenance	100	209

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INDEX

	Paragraph	Page
Poles:		
Assembly	93	194
Description	79	165
Dismounting	93	194
Maintenance	100	209
Post, aiming, M1	48	90
Precautions, for subcaliber equipment	120	236
Preservatives	39	40
Quadrants:		
Gunner's	49	91
Range	50	94
Range finder, 1-m base, M1916	56	126
Recoil mechanism:		
Care and preservation	33	30
Dismounting and mounting:		
Gun carriage M1897, M1897MIA2, and M1897A2	15	15
Gun carriage M2A2	22	17
Malfunctions	30	25
Subcaliber, description	114	229
Recoil oil	34	32
References	App.	247
Setter, fuze, bracket, M1916	57	132
Shield, gun carriage, M1897, M1897MIA2, and M1897A4, removal	13	14
Sighting, bore, with subcaliber equipment	124	242
Sighting equipment	43–53	78
Inspection and adjustment	28	23
Sights:		
Bore	51	95
M1901 (French)	52	97
Singletrees	80	165
Snaps, bolt	82	166
Spare parts:		
75-mm gun	108	219
Subcaliber equipment	126	243
Special field artillery vehicles	93–98	194
Wheel hub, carriage, M2A2, from spindle	24	19
Wheels, carriage, M1897 and M1897MIA2	17	16
Support, pole, automatic:		
Adjusting	94	196
Description	87	179
Mounting	94	196
Table, firing	58	133
Target, testing	53	104
Telescopes:		
Battery commander's, M1915	59	133
Mounts:		
M15	44	79
M15A1 and M22	45	86

	Paragraph	Page
Telescopes—Continued.		
Panoramic:		
Mounts M5 and M5A2	44	79
Mounts M5A4 and M12A1	45	86
Tools, gun	42	44
Vehicles, special field artillery:		
Care and preservation	100–107	209
Data	73–77	162
Description and operation	84–92	168
Disassembly and assembly	93–98	194
Inspection	99	208
Parts common to several vehicles	78–83	163
Wheel hub, carriage M2A2, disassembly from spindle	24	19
Wheels:		
Carriage M1897 and M1897MIA2, removal and assembly	17	16
Carriage M2A2, assembly	25	19
Wheels, special field artillery:		
Description	78	163
Disassembly and assembly	93	194
Maintenance	100	209
Yokes, neck:		
Description	80	165
Dismounting	93	194
Mounting	93	194

[A. G. 062.11 (9-29-41).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

Official:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

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(For explanation of symbols see FM 21–6.)

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TECHNICAL MANUAL

75-MM GUN MATÉRIEL M1897 AND MODIFICATIONS

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON, January 5, 1943.

TM 9–305, May 18, 1942, is changed as follows:

8. Operation of breech and firing mechanism.

* * * * * * *

b. Firing mechanism.

* * * * * * *

(2) Safety piece (fig. 6) is provided * * * of the breechblock arm. (On guns of French manufacture, these two points are marked **"Route" (safe) and "Tir" (fire).**

[A. G. 062.11 (12–22–42).] (C 1, Jan. 5, 1943.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
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OFFICIAL:

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Major General,
The Adjutant General.

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